APPLICATION

Study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science" for assessment

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
Title of the higher education institution	*Rīgas Tehniskā universitāte*
Registration code	*3341000709*
Legal address	*KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050*
Phone number	*67089300*
E-mail	*rtu@rtu.lv*

Self-evaluation report

Study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science"

Riga Technical University

Table of content

1. Information on the Higher Education Institution/College

1.1. Basic information on the higher education institution/ college and its strategic development fields,.

Riga Technical University was founded in 1862 as Riga Polytechnic, later Riga Polytechnic Institute, and is the oldest technical university in the Baltic States. Following the restoration of the Republic of Latvia in March 1990, Riga Polytechnic Institute was renamed Riga Technical University (RTU). Over years RTU has become the leading centre of higher engineering education and science in Latvia, obtained a positive assessment of international experts and has been accredited by the Supreme Education Council of the Republic of Latvia.

RTU values include sustainable development, quality, openness and cooperation, creativity, academic freedom, motivation to explore and discover.

At the beginning of academic year 2021/2022, an academic and scientific staff of 1,193 people work at nine faculties of RTU (Faculty of Architecture; Faculty of Civil Engineering; Faculty of Computer Science and Information Technology; Faculty of E-Learning Technologies and Humanities; Faculty of Electronics and Telecommunications; Faculty of Electrical and Environmental Engineering; Faculty of Engineering Economics and Management; Faculty of Mechanical Engineering, Transport and Aeronautics; Faculty of Materials Science and Applied Chemistry) and four RTU Study and Science Centres in Cēsis, Liepaja, Ventspils and Daugavpils carrying out high-quality academic activities and scientific research at a contemporary level. RTU is the second largest university in the Republic of Latvia in terms of student number and has educated and trained more than 160,000 graduates in total.

RTU carries out active study and research work, acquiring new partners worldwide, working together on project implementation, student exchange and the development of joint study programmes. Active development of a student campus is underway in Ķīpsala, where new faculty buildings are being built, while those built during earlier years are getting a new look, modern content and design.

Many research and scientific projects are being carried out in cooperation with RTU partners, which result in both new patents and successful business activities. RTU successfully develops cooperation to strengthen its role in the development of higher engineering education in the world and in the development of Latvia.

RTU has defined its mission – we are building a competitive, educated, innovative and creative future, the vision – an internationally competitive, dynamic and modern university of science and technology.

Accredited RTU study fields and number of study programmes in May 2022:

Study field	**Number of study programmes**
Architecture and Construction	20

Economics	3
Energy, Electrical Engineering and Electrical Technologies	15
Physics, Materials Science, Mathematics and Statistics	9
Internal Security and Civil Defence	6
Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science *	38
Chemistry, Chemical Technology and Biotechnology	10
Mechanics and Metalworking, Thermal Energy, Thermal Engineering and Mechanical Engineering	28
Manufacture and Processing	6
Translation	2
Management, Administration, Real Estate Management	21
Environment Protection	6
Total:	**164**

* Twelve study programmes are not subject to re-accreditation.

The offer of RTU study programmes is in compliance with the forecasts with regard to the needs of the labour market in both Europe and Latvia in the coming decade. The RTU study programme offer ensures education and training of the specialists in information and communication technologies (ICT), engineering, management and humanities, for which a significant shortage in the labour market is predicted.

In recent years, the number of foreign students studying to obtain a degree or qualification in Latvia has increased. In addition, international student mobility growth is projected to continue also in the future. In academic year 2019/2020, there were by 25% more foreign students studying at RTU in comparison with academic year 2018/2019. Taking into account the above mentioned, RTU has great opportunities to further increase the number of foreign students. It also provides an appropriate offer of RTU study programmes in English – 16 Bachelor study programmes, 27 Master study programmes, and 13 Doctoral study programmes, moreover, this list is updated from year to year.

Dynamics of the number of students in the RTU during the evaluation period:

Academic year	Total number of students
2013./2014.	14,452
2014./2015.	14,797
2015./2016.	14,997
2016./2017.	14,672
2017./2018.	14,322
2018./2019.	14,383
2019./2020.	14,006
2020./2021.	13,237 *

* In May 2022, 13,372 students studied at RTU – 9,719 studied at undergraduate study programmes, 3,128 studied at graduate Master degree programmes and 525 – at the Doctoral study programmes.

The guiding principle of RTU Strategy for 2021–2025 is the proactive link between the activity of the university and the needs of the national economy, focus on high quality and effectiveness. The basis for the activity of RTU is the study process built on science, innovation and in cooperation with the industry, which ensures preparation of specialists required by the Latvian national economy, thus serving as a foundation for sustainable growth of Latvia. The RTU's strategy for the new programming period is a consecutive continuation is the previous strategy of the university for 2014-2020. It has been developed in compliance with the objectives and priorities defined in Latvian development planning documents.

According to the National Development Plan for 2021-2027 of Latvia, fundamental changes are planned in the near future in four directions – *Equal Rights, Quality of Life, Knowledge Society, and Responsible Latvia,* in the achievement of which a high-quality study process, excellent research, as well as sustainable innovation and commercialization activities play an important role, which are important elements in RTU's vision to become an internationally competitive, dynamic and modern university of science and technology.

Keynote of the RTU Strategy: High quality and effectiveness – proactive link between the activity of RTU and the needs of the national economy. RTU is one of the leading science and technology universities of the Baltic and Nordic region, which is acting based on a study systems built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies.

In order to implement RTU's vision to become an internationally competitive, dynamic and modern university of science and technology, RTU's strategy defines four main objectives for the next programming period, three of which are related to the implementation of basic university functions: excellent science, quality studies and sustainable valorisation. The fourth, institutional excellence, is related to the university support function and the development of internal governance in the six areas: digitalisation, sustainable development, effective financial and administrative action, internationalisation, communication and cooperation, human resources development. For all the objectives identified in the strategy define specific tasks to be performed and result indicators to make it possible to follow the implementation of the strategy so that RTU can realise its vision.

The implementation of the RTU Strategy is approved by a decision of the RTU Senate. Following the approval of the Strategy, RTU Rector once a year ensures definition of the annual RTU aims and tasks with clear performance indicators set at the level of each RTU unit. RTU Strategy is implemented, and the results achieved are analysed annually with regard to the defined tasks.

RTU Strategy is published at https://www.rtu.lv/en/university/strategy.

1.2. Description of the management structure of the higher education institution/ college, the main institutions involved in the decision-making process, their composition (percentage depending on the position, for instance, the academic staff, administrative staff members, students), and the powers of these institutions.

The structure and administration of RTU are established in compliance with the University vision, mission and objectives and taking into account the specifics of the University management. The administrative structure is based on a decentralized decision-making process and obligations arising from the Law on the Higher Education Institutions, the Constitution of RTU, resolutions of RTU Senate, the orders issued by the Rector, as well as other RTU documents. The functions of various organizational units have been approved in their regulations approved by the Senate.

On 16 August 2021, the amending laws to the Law on Higher Education Institutions entered into force, which envisages changes in the internal management model and the procedure for electing rector, as well as defines a new typology of higher education institutions, setting specific eligibility criteria for each type. According to the new typology, RTU corresponds to the status of a university of science. Changes in the Law on Higher Education Institutions are one of the most important steps to create a modern, effectively managed higher education system in Latvia, based on science and research, oriented towards excellence, being internationally competitive and stimulating the country's economic development.

In view of this, during 2021/2022 academic year RTU is undergoing an intensive change process. On 31 August 2021, the new regulations of the RTU Senate were approved, on 20 September 2021 the new RTU Senate was elected. The RTU’s Council was established in March 2022, a new Constitutional Assembly and a new Constitution must be developed and adopted by summer of 2022. From the management point of view, the changes included in the amendments to the law concern the election process of a rector, the appointment/ dismissal of deans, the establishment / reorganization of structural units based on the proposal of the rector.

The council of the higher education institution is a collegial highest decision-making body responsible for the sustainable development, strategic and financial supervision of the university, but the senate will be responsible for the development of university’s studies and scientific processes. The council must also ensure the operation of the state higher education institution in accordance with the goals set in its development strategy. The RTU Council consists of five representatives nominated by the RTU Senate, five external representatives of society or industry, who are not professionally related to the university, but whose presence allows the university to respond more flexibly to external changes and expand its strategic vision. The election of external representatives takes place in accordance with the regulations approved by the Cabinet, which ensures the transparency and political neutrality of the process. The council also has a representative nominated by the President of Latvia, thus facilitating strategical focus of the university according to development goals of the state.

Overall, RTU management can be divided into three levels: university level, administration level and faculty level.

At the University level, there is the Constitutional Assembly (200 representatives – 120 academic personnel representatives (60% of the total number), 40 student representatives (20% of the total number) and 40 general staff representatives (20% of the total number). The Assembly includes all 35 members of the RTU Senate, the other 165 members are elected by the central administration, faculties, and institutes that are not part of the faculties, study and science centres and the students' self-government in the amount to ensure proportional representation. The conditions for the formation of the Assembly are defined in Part II of the RTU Constitution – see the file of Annex 01 of the list of Internal regulations).

There are 35 senators in the Senate, of which 27 are representatives of the academic staff (not less than 75% of the representatives, including at least 14 professors or associate professors – not less than 50% of the total number of senators), seven students (not less than 20% of the total number of senators) and the Rector is a member of the Senate in accordance with the position. The conditions for the election of the representatives of the Senate are defined in the attached Article 7 of the Regulation of the Senate of RTU – see the file of Annex 02 of the list of Internal regulations).

RTU Scientific Council, which consists of Deputy Deans in for research, Vice-Rector for Research, Deputy Vice-Rector for Research; and representatives of doctoral students; the Rector, Vice-Rector for Academic Affairs, Vice- Rector for Strategic Development, Vice-Rector for Finance, and the Chair of the Senate also have the rights of membership of the Council.

At the level of administration, the operational management of the university is exercised by the Rector, whereas the Board of the Rector plays an advisory role in the adoption of such decisions, with the participation of the Rector, Chair of the Senate, Vice-Rectors, Administrative Director, Deputy Rector for Digital Transformation, Deputy Rector for International Academic Cooperation and Studies, Director of the Legal Department, Director of Infrastructure Development Department, President of the Student Parliament; the Deans Council comprising the Rector, Deans, directors of studies and research centres, Director of Riga Business School, Chair of the Senate, Vice-Rectors, Deputy Rector for International Academic Cooperation and Studies, Director of Infrastructure Development Department, President of the Student Parliament; operational management meetings uniting the Rector, Administrative Director, Deputy Vice-Rector for Research in Scientific Work, the heads of administrative departments (department directors, unit managers). At the faculty level, the highest decision-making bodies are faculty councils whose composition depends on the size of the faculty.

External partners and stakeholders are involved in the University management through the RTU Advisory Board (27 members). It provides an opportunity to receive independent opinion on important issues and possible solutions from various perspectives. Each faculty also has its own Advisory Board, which provides its own vision for improving the supply of study programmes in line with sectoral needs and market trends.

Each faculty also has its own student self-government, while RTU Student Parliament coordinates faculty student self-governments. Students are represented in all RTU decision-making bodies and can therefore participate in the University strategic decision-making.

The Rector, Vice-Rector for Research, Vice-Rector for Academic Affairs, Vice-Rector for Finance and Vice-Rector for Strategic Development are the senior officials of RTU. The Rector implements the general administrative management of RTU and represents RTU without a specific mandate. The

Rector is elected by the Constitutional Assembly for a period of five years for no more than two consecutive terms for the same person. The Rector is elected, approved in office and removed from office pursuant to the regulatory enactments governing higher education institutions.

The operational management of RTU is exercised independently, in accordance with the delegation of the Rector, by the Vice-Rector for Research, Vice-Rector for Academic Affairs, Vice-Rector for Strategic Development and Vice-Rector for Finance. The Senate elects the Vice-Rector for Research, Vice- Rector for Academic Affairs, Vice-Rector for Strategic Development and Vice-Rector for Finance based on the recommendation of the Rector for the term of office of the Rector. The Rector may also delegate certain functions to other RTU officials and, on the basis of the Rector's proposal; other Vice-Rector positions may be created by a Senate decision.

The Vice-Rector for Research supervises and is responsible for Doctoral study programmes and research work, including support to young researchers, research infrastructure, research funding, applied research, intellectual property protection, RTU scientific publications and scientific conferences. The Vice-Rector for Academic Affairs supervises and is responsible for the study process at the Bachelor, Master, first and second-level professional study programmes, further education, including training programs, security and quality assurance in studies, credit points, determination of academic staff positions and workload, as well as the selection and admission of students. The Vice-Rector for Strategic Development is responsible for the development strategy and its successful implementation, supervises the implementation of projects important for the development of RTU, and represents the interests of RTU in interaction with public authorities, partners and the public. The Vice-Rector for Finance is responsible for the financial management processes of RTU and for allocating and planning financial resources to ensure the functioning of RTU and implementation of the development strategy.

The accounting, study administration, science administration and human resources administration at the university are centralized. Other administrative processes, such as procurement and project management, are centralized to the extent necessary to avoid institutional risks. At the same time, a decentralized management system has been provided at a high level at RTU, with a certain degree of autonomy for each academic unit. This means they have their own budget and self-governing structure, which allows defining and meeting the objectives of the organizational unit. This approach motivates the heads of departments to be proactive, to plan the development of the unit, and to apply for funding.

RTU governance structure information is published at https://www.rtu.lv/en/university/structure-and-administration.

1.3. Description of the mechanism for the implementation of the quality policy and the procedures for the assurance of the quality of higher education. Description of the stakeholders involved in the development and improvement of the quality assurance system and their role in these processes.

The RTU has established an internal quality management system that respects the standards of Part 1 of the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).

RTU internal quality management system works in line with the “Excellence approach” (approved on 30 January 2017 at the meeting of the RTU Senate, Minutes No 606), as well as the “RTU Quality

Policy” (approved by the Senate on 25 September 2017, Minutes No 612).

The Quality Policy is focused on the implementation of the RTU mission and the achievement of the strategic objectives. The Quality Policy lays out the framework and pathways for development and improvements of the RTU Strategy, research, study process and organization. The University Quality Policy is aligned with the European Association for Quality Assurance in Higher Education (ENQA) standards and guidelines. The RTU Excellence Approach and quality policy are mutually integrated documents which require RTU to use the quality model of the European Foundation for Quality Management (EFQM).

The EFQM quality model assumes cooperation with student representatives, partners, professional associations, student organizations, other higher education institutions, businesses and organizations. RTU maintains an open dialogue to explore the needs of the parties involved and to respond appropriately by developing feedback to day-to-day and long-term cooperation.

By establishing links with the parties involved, the administration of RTU contributes to the development of excellence and ensures the clarity, unity, building of the work environment and diversity management of the objectives to be achieved.

RTU staff participates in quality assurance by providing suggestions and feedback to improve the RTU quality system. The heads of the RTU departments are responsible for carrying out internal quality assurance procedures and processes in their departments.

Based on the results of regular student and graduate surveys, improvements in the quality of the study process are being planned.

Cooperation with partners, suppliers and other stakeholders takes place in accordance with the RTU Strategy, establishing appropriate cooperation networks and identifying appropriate policies, activities and processes for effective cooperation aimed at ensuring the quality of the RTU and acquisition of feedback. To ensure the topicality and continuous development of existing study programmes and before the introduction of new study programmes the interests of all stakeholders in modern and interdisciplinary technology education are considered.

External stakeholders (public authorities, cooperation partners, representatives of the public) assess the study process and its results in State Examinations, practical placements (internships) and accreditation, and contribute to improving the content and quality of study programmes.

More on this point is set out in Section 2.1.1.

RTU Excellence Approach is published at https://www.rtu.lv/en/university/strategy/rtu-excellence-approach.

RTU Quality Policy in Latvian is published at https://www.rtu.lv/lv/universitate/dokumenti/kvalitates-politika (The English translation is in the file of Appendix 03 of the List Internal regulations).

1.4. Fill in the table on the compliance of the internal quality assurance system of the higher education institution/ college with the provisions of Section 5, Paragraph 2(1) of the Law on Higher Education Institutions by providing a justification for the given statement. In addition, it is also possible to refer to the respective chapter of the Self-Assessment Report, where the provided information serves as justification.

1.	The higher education institution/ college has established a policy and procedures for assuring the quality of higher education.	In line with the quality model introduced by RTU, process analysis and improvement are ongoing. Performance indicators and the results of the assessment of various surveys are analysed. The quality report data are compiled after the end of the academic year. Annual agreements on the target study process performance indicators are signed with the faculties; the quality is assessed by analysing the achievement of the defined objectives relative to the plan. For more details, see the 5th row of this table.
2.	A mechanism for the creation and internal approval of the study programmes of the higher education institution/ college, as well as the supervision of their performance and periodic inspection thereof, has been developed.	The development of study programmes takes place in accordance with the “Procedure for the application, elaboration and amendment of the study programmes” (approved at the Meeting of RTU Senate on 26 April 2021, Minutes No 649). The departments and institutes implementing the study process, Faculty Councils, the Office of Vice-Rector for Academic Affairs, the Student Parliament and the Senate are involved in ensuring the internal study quality of RTU. These institutions carry out comprehensive assessment of the new study fields and study programmes, the changes to the study fields and programmes and the annual reports of the improvement of the study fields. At RTU, the operation of the internal quality assurance mechanism takes place at the level of the Rectorate, faculties, study fields and study programmes. At the level of the Rectorate, the internal study quality control of RTU is carried out by the Office of Vice-Rector for Academic Affairs. The Study Department performs: (1) the maintenance and control of the Study Programme Register, which involves control of the conformity of the study curriculum to the aims, tasks and learning outcomes of the study programme, as well as the control of changes; (2) maintenance and control of the Study Course Register, which involves control of the conformity of study course descriptions with the learning outcomes, as well as quality control of study course descriptions; (3) periodical student polling at the University level.
3.	The criteria, conditions, and procedures for the evaluation of students’ results, which enable reassurance of the achievement of the intended learning outcomes, have been developed and made public.	The evaluation of learning outcomes takes place in accordance with the “Regulation on the Assessment of Learning Outcomes” (approved at the Meeting of RTU Senate on 29 May 2017, Minutes No 610) and “Regulation on Final Examinations at RTU” (approved at the Meeting of RTU Senate on 26 April 2021, Minutes No 649).

4.	Internal procedures and mechanisms for assuring the qualifications of the academic staff and the work quality have been developed.	In order to ensure the qualification and performance quality of academic staff, professional advancement needs are regularly assessed when evaluating the results. Professional advancement training modules are developed by collecting information from: (1) academic staff surveys on professional advancement needs once in two years; (2) analysis of student polling results; (3) cooperation with student self-governments; (4) world trends and good practices of other Latvian universities in the field of professional advancement of academic staff; (5) information provided by academic staff on professional advancement topics of interest; (6) proposals from the heads of academic units for professional advancement of academic staff. The Centre for Academic Excellence (CAE), a teaching and learning centre, was set up at the end of 2018; its aim is to develop a strategy for the professional advancement of academic staff, including in line with Article 16 of Cabinet Regulations No. 569. Other tasks of CAE are detailed in Section 3.5. Academic units organize regular or one-time professional advancement activities having assessed the need for professional training of academic staff. The units assess whether it is more appropriate to participate in a particular event for certain representatives of academic staff, all members of the unit or to invite also members from other units.

5.	The higher education institution/ college ensures the collection and analysis of the information on the study achievements of the students, employment of the graduates, satisfaction of the students with the study programme, efficiency of the work of the academic staff, the study funds available, and the disbursements thereof, as well as the key performance indicators of the higher education institution/ college.	Student expectations and satisfaction with the curriculum and study process are identified in sequential and planned surveys at all stages of study. Student surveys are organized in accordance with the Regulations on “Student Polling for Assessment of the Study Process” (approved by the resolution of RTU Vice-Rector for Academic Affairs No 02000-1.1-e/8 as of 1 February 2021). The aim of polling is to clarify the adaptation of first year students to the university system and the satisfaction of all students with the study process, lectures, and practical classes after each semester, the satisfaction of students with the services offered by the University, and the overall satisfaction of graduates with the study programme. The results of the surveys are available to academic staff, heads of organizational units and students in a summarized form. Annually, the State Revenue Service provides information on employment of RTU graduates. The Total Quality Management System of RTU analyses performance results of the study process, comparing the characteristics of the study programmes, including the resulting performance indicators related to the study process in the overall EFQM quality model of RTU. At the beginning of September of each year, a faculty Activity Plan on study process indicators is drawn up: (1) number of students; (2) number of graduates; (3) number of graduates who complete their studies on time; (4) number of students expelled from University; (5) number of foreign students; (6) average age of elected academic staff; (7) number of study programmes implemented in English; (8) average indicator of the evaluation of faculty academic staff; (9) number of persons with a scientific degree elected to academic positions (%); (10) number of foreign guest lecturers. The established Faculty Study Activity Plans for the following year are drawn up by Faculty Deans, together with Deputy Deans for Academic Affairs and institute directors; they are approved by the Rector of RTU. RTU administration meets with representatives of faculties to evaluate the faculty activity plans on study process indicators, evaluating the progress in the previous academic year and defining the indicators to be achieved in the next two academic years. These indicators are used to monitor study process performance of the faculty. These indicators and other aspects influence the amount of performance-based funding allocated to the faculty and contribute to the achievement of the objectives set forward in the RTU Strategy. The study process funds are administered in accordance with methodologies approved by the Senate or as stipulated by the Vice-Rector for Finance. Principles of the methodologies motivate the heads of departments to be proactive, to plan the development of the unit, and to apply for funding. These methodologies are described in more detail in section 2.3.1. of the self-assessment report.

6.	The higher education institution/ college shall ensure continuous improvement, development, and efficient performance of the study field whilst implementing their quality assurance systems.	At the level of the faculty and study field, internal quality is ensured by the Faculty Council, the Study field Committee and Directors of the study field, Directors of the study programmes, administration of the institutes and chairs implementing study programmes. Within the framework of the study programme, internal quality is ensured by the program director and by the academic staff implementing the program. Internal quality control at the level of the study programme is carried out by the administration of the relevant institute or chair. In order to ensure continuous development of the study programmes, RTU Study field Committees monitor academic activities in the relevant study field and are responsible for the curriculum and quality of the study programmes within the study field, including the accreditation of the study field. Inclusion of employer representatives in the Study field Committee is a mandatory requirement. Study field Committee acts in accordance with the "Regulation of the Study field Committee" (approved by the Resolution of RTU Senate Meeting on 26 April 2021, Minutes No 649). The basic tasks of the Study field Committee are: (1) to analyse the situation in the labour market and make suggestions for the development of new study programmes as well as for the closure of the outdated study programmes; (2) to carry out expert assessment of the curriculum and quality of the study programmes, assess their compliance with the defined objectives and compliance with the research area represented and labour market requirements; (3) to organize and monitor the accreditation of the study field and the licensing of study programmes; (4) to analyse the assessment and recommendations made by external experts and organize elimination of identified shortcomings; (5) to carry out an analysis of the study field self-assessment report as well as the annual reports on study field development activities; (6) in order to achieve strategic objectives of the University, to assess the proposed changes to study programmes with a view to increasing the quality of all study programmes included in the study fields; (7) to analyse the results of student, graduate and employee surveys and organize elimination of identified shortcomings, as well as organize additional surveys.

2.1. Management of the Study Field

2.1.1. Aims of the study field and their compliance with the scope of activities of the higher education institution/ college, the strategic development fields, as well as the development needs of the society and the national economy. The assessment of the interrelation of the study field and the study programmes included in it.

The main goal of the study field is to fulfil the agenda of digital transformation of Latvia and to attain regional technological leadership adopting excellent research, modern interdisciplinary studies based on cross-border cooperation, and effective interdisciplinary cooperation through joint development initiatives as the main driving force.

At RTU, the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” is implemented by several organizational units – Faculty of Computer Science and Information Technology (FCSIT), Faculty of Electronics and Telecommunication (FET), Faculty of E-Learning Technology and Humanities (FETH) and Riga Business School (RBS).

In May 2022, there are 38 study programmes in the field of study, of which, both within the framework of optimization and to ensure more efficient management, 12 study programmes are not being re-accredited - some of them are already closed and some will be closed in the near future (for example, academic and prof. “Automation and Computer Engineering ”, 1st level prof. Higher education “Computer Systems ”, etc.). There are programmes which are combined into a new programme, too. For example, the doctoral study programme “Computer Science and Information Technology” was created (license received on 30.06.2021), combining all 3 doctoral study programmes implemented by FCST. The study programmes developed during the reporting period are “Computer Science and Organizational Technologies” (academic bachelor), “Smart Electronic Systems” (prof. bachelor, created by reorganizing the previous study programme “Electronics”), “Cyber Security Engineering” (academic master), ‘Computer Science and Information Technology’ (PhD) and "Digital Humanities" (academic master).

Out of 26 study programmes directed to accreditation (study programmes licensed during the reporting period) or re-accreditation (study programmes accredited in 2013), 18 are academic and 8 are professional study programmes of various levels. Implementation of study programmes in structural units:

FCST implements *15 study programmes*, of which *11 are academic* - 4 bachelor's, 6 master's and 1 doctoral study programmes, and *4 professional* - 2 bachelor's (one of which is a joint study programme with the School of Business and Finance) and 2 master's study programmes.

FET implements *8 study programmes*, of which *4 are academic* - 1 bachelor, 1 master and 2 doctoral study programmes, and *4 professional* - 2 bachelor and 2 master level study programmes.

FETH implements *2 academic study programmes* - 1 master's and 1 doctoral study programme.

RBS implements *1 academic bachelor study program*.

The following table lists the study programmes to be submitted for re-accreditation or accreditation (licensed during the reporting period):

Programme code	The title of the study programme	Faculty
43526	Academic bachelor study programme “Smart Computer Technologies" (previously “Automation and Computer Engineering”)	FCST
45526	Academic master study programme "Business Informatics"	FCST
42526	Professional bachelor study programme "Computer Systems"	FCST
43526	Academic bachelor study programme "Computer Systems"	FCST
45526	Academic master study programme "Computer Systems"	FCST
47526	Professional master study programme "Computer Systems"	FCST
51482	Doctoral study programme "Computer Science and Information Technology"	FCST
43483	Academic bachelor study programme "Computer Science and Organizational Technologies"	RBS
45526	Academic master study programme "Digital Humanities"	FETH
51523	Doctoral study programme "Electronics"	FET
51482	Doctoral study programme "E-Learning Technology and Management"	FETH
42484	Professional bachelor study programme "Finance Management Information Systems" (a joint study programme with the School of Business and Finance)	FCST
43526	Academic bachelor study programme "Information Technology"	FCST
45526	Academic master study programme "Information Technology"	FCST
47483	Professional master study programme "Information Technology Project Management" (previously “Information Technology”)	FCST
43526	Academic bachelor study programme "Intelligent Robotic Systems"	FCST
45526	Academic master study programme "Intelligent Robotic Systems"	FCST
45526	Academic master study programme "Cybersecurity Engineering"	FCST
45526	Academic master study programme "Logistics and Supply Chain Management"	FCST

43526	Academic bachelor study programme "Telecommunication Technologies and Data Transmission Engineering" (previously “Telecommunication”)	FET
45526	Academic master study programme "Telecommunication Technologies and Networks Management" (previously “Telecommunication”)	FET
51523	Doctoral study programme "Telecommunication"	FET
42523	Professional bachelor study programme "Transport Electronics and Telematics"	FET
47523	Professional master study programme "Transport Electronics and Telematics"	FET
42523	Professional bachelor study programme "Smart Electronic Systems"	FET
47523	Professional master study programme "Smart Electronic Systems"	FET

During the previous accreditation period, the code of the study programmes - “Business Informatics”, “Computer Systems”, “Information Technology”, “Intelligent Robotic Systems” - was **481**, which was in the group of **Computer Science** education programmes of the thematic group of **Natural Science, Mathematics and Information Technology**. Regulations of the Cabinet of Ministers of the Republic of Latvia of 13 June 2017 No. 322 provides for a change of this code.

Degrees to be awarded and the content of study programmes "Smart Computer Technologies", "Telecommunication Technologies and Data Transmission Engineering", "Telecommunication Technologies and Network Management" do not correspond to the current classification code **523** (Education thematic groups **Engineering, production and construction** thematic areas **Engineering and technology** Education programme group **Electronics and automation**).

The previous classification code **482** (Education thematic groups **Natural Science, Mathematics and Information Technology** thematic areas **Computers** Education programme group **Computer systems, databases and computer networks**) of the study programme “Digital Humanities” does not correspond to the thematic area and the degree to be awarded and therefore also need to be clarified.

Taking into account changes in the classification of educational fields, changes in programme content, parameters, based on RTU's vision of engineering and technology as a strategic area of specialization, as well as taking into account global trends in the respective field of science, representatives of study field commission, leading lecturers, representatives of student self-government agreed that the most appropriate for the mentioned study programmes are the thematic areas **Engineering and Technology** Education programme groups **Other Engineering** with classification code **526**. The structural units implementing the given study programmes operate in the field of Electrical Engineering, Electronics, Information and Communication Technology and also the study programmes are developed in accordance with the unified RTU requirements for study programmes (see the file of Annex 05 of the List of Internal Regulations). The regulations envisages the inclusion of study courses which are typical to engineering sciences in the part of compulsory study courses.

An explanation for the change of the educational classifiction code (and also according to changes in the degree to be obtained) to **526** (Thematic areas **Engineering and Technology** Education Group **Other Engineering**) is given in the attached annex (*2.1.1_ClassCode_Change_Explanation_EN.pdf*). Justification for the other changes in content, form and characteristics of the study programmes is given in the description of each study programme.

Several study programmes in the study field are implemented in cooperation with other Latvian or foreign HEIs:

- Academic Master study programme “Logistics Systems and Supply Chain Management” is implemented jointly with Universitat Autònoma de Barcelona, Spain, Hochschule Wildau, Germany, and Montanuniversität Leoben, Austria;
- Academic Master study programme “Business Informatics” is implemented in cooperation with the State University of New York - University at Buffalo, USA;
- Academic Bachelor study programme “Computer Science and Organizational Technologies” is implemented jointly with the University of Latvia and the State University of New York - University at Buffalo, USA;
- Professional Bachelor study programme “Finance Management Information Systems” is implemented in cooperation with BA School of Business and Finance;
- Academic Bachelor and Academic Master study programmes “Intelligent Robotic Systems” are implemented within the framework of the effective cooperation agreement with the University of Tartu, Estonia.

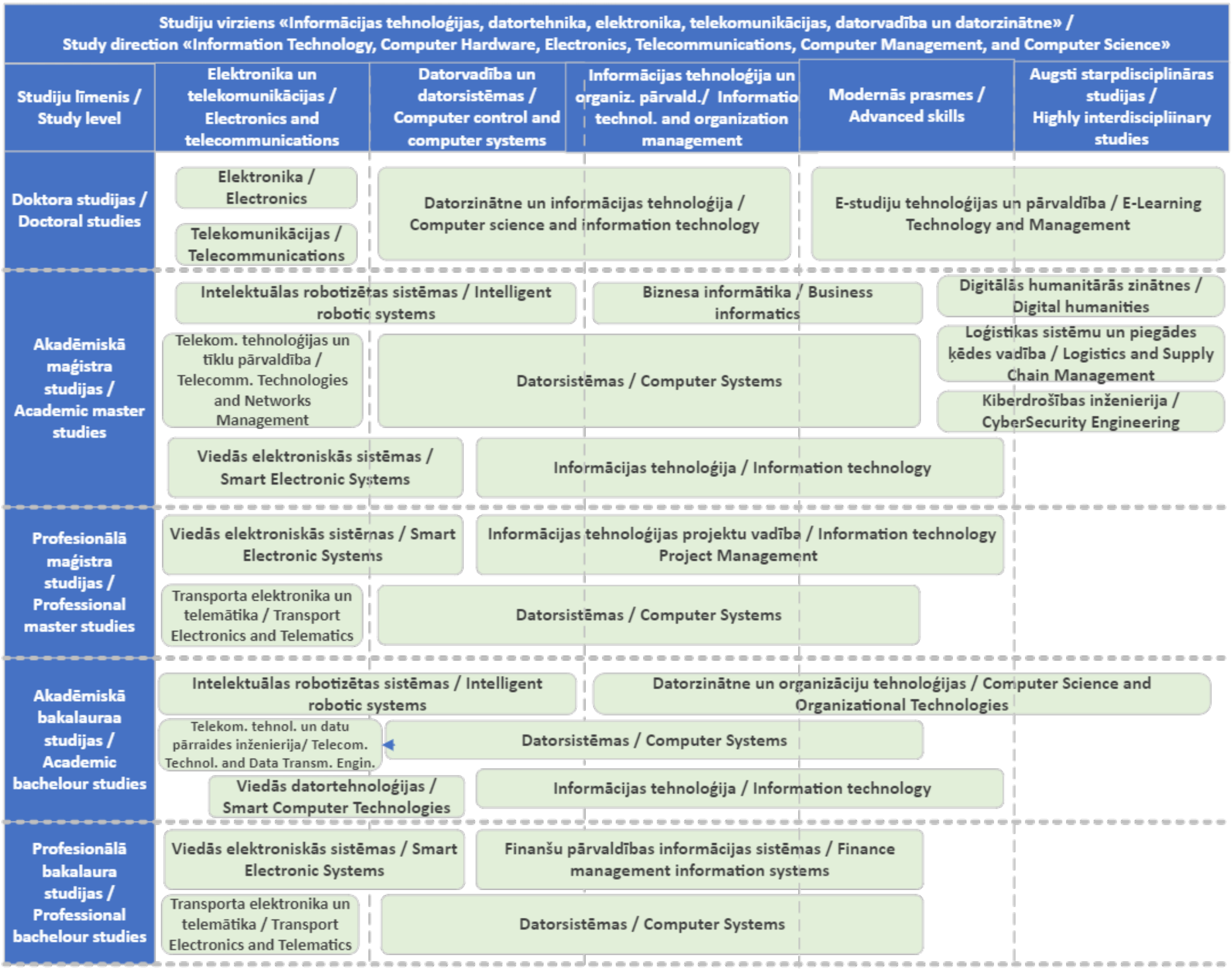
All study programmes mentioned above are interdisciplinary, which is in full compliance with the core aim of the study field and the current industry trends. Apart from these programmes, there are several interdisciplinary programmes that are implemented only by RTU, significantly complementing the range of engineering programmes specific to the field:

- Academic Master study programme “Digital Humanities” integrates digital skills in humanities, social sciences and arts, focusing on the horizontal impact of the digital skills and knowledge in various fields;
- Academic Master study programme “Cybersecurity Engineering”;
- PhD study programme “E-Learning Technologies and Management”.

Taking into consideration the quality of the study programmes included in the study field and their contribution to the development of the national economy of Latvia, by the resolution of the Study Accreditation Committee of the Ministry of Education and Science (MES) of the Republic of Latvia No 77 as of 13 May 2013, the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” and all study programmes included therein were accredited for the period of six years. Since the establishment of the study field, it is one of the largest study fields at RTU and Latvia in terms of the number of students, providing education to approximately 2,500 students, of which about 20% are foreign students. Many study programmes are unique for Latvia (see also the description of each study programme), they are not offered by other Latvian higher education institutions.

The fact that the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” is represented at the leading Latvian technical HEI – RTU – has always been and in future will be even more important precondition for implementation of cross-disciplinary projects involving the government, various fields of engineering, and industry specialists. Study programmes implemented within the study field are directly focused on achieving Latvia’s sustainability goals. They promote comprehensive commercialization of engineering inventions and innovations created at other RTU faculties, which is essential for the development of the innovative, manufacturing and industrial economy in Latvia.

The study programmes included in the study field cover all education cycles from the Bachelor to PhD study programmes. The interrelation of study programmes is given in the figure below:



In accordance with the current industry trends and good practices of education governance, the structure of the study programmes is integrated both along the fields of study (horizontally) and by cycles (vertically), providing students with a sufficiently flexible study environment. Students can select their own learning path, timely adapting to the changing industry requirements.

With every next education cycle, selecting the appropriate specialization, students gain wider opportunities to engage in interdisciplinary studies or studies developing modern skills. It should be emphasized that each study programme in the study field includes study courses aimed at development of modern skills. Students are offered an opportunity to independently adjust the volume and intensity of the corresponding courses.

In order to ensure flexibility of the study process, students are also provided with the opportunity to study according to the individual study plan, which in its turn allows them to modify the study programme in its implementation process, at the same time taking care of achieving the aims of the study programme and acquiring the appropriate competences and skills. This can be realized by transferring credit points and providing the opportunity for the students to acquire the necessary study courses in addition to their current study programme during studies.

The study programmes included in the field have been developed and launched at different times, always in compliance with the effective regulatory documents. All professional study programmes in the study field also comply with the occupational standards that regulate the qualifications students obtain upon completion of these study programmes.

2.1.2. SWOT analysis of the study field with regard to the set aims by providing explanations on how the higher education institution/ college expects to eliminate/ improve weaknesses, prevent threats, and avail themselves of the given opportunities, etc. The assessment of the plan for the development of the study field for the next six years and the procedure of the elaboration thereof. In case there is no development plan elaborated or the aims/ objectives are set for a shorter period of time, information on the elaboration of the plan for the development of the study field for the next assessment period shall be provided.

In order to ensure the quality of the study field, a report on the improvement of the study field was drafted annually (until 2018). The report was evaluated by an expert appointed by the Vice-Rector for Academic Affairs and approved by the RTU Senate. The annual reports on the study field improvement (until 2018) are available at https://www.rtu.lv/lv/universitate/dokumenti/studiju-virzienu-ikgadejie-parskati (only in Latvian).

SWOT analysis is an integral part of the improvement report, which allows focusing on the achievements and highlighting the problems. It is an essential tool for achieving the aims of the study field. The development of the study field is part of RTU Strategy, which allows considering the aspects of the study field SWOT in the context of RTU Strategy, which examines the internal and external factors separately.

Internal Factors

Strengths	
Human resources	· Highly qualified academic staff; · Professional development of academic staff and gaining experience abroad.
Curriculum	· The fields of computer science and ICT are in high demand and are developing, thus the popularity of study programmes is relatively high, resulting in the entry competition in several study programmes; · Study programmes developed in accordance with the industry standards in cooperation with foreign guest lecturers and industry experts, which ensures high quality of the curriculum; · Balanced acquisition of the theoretical, practical and technical knowledge and skills within the study courses; · An active digitalization process of the study courses is underway, introducing MOOCs and digitizing various elements of the curriculum; · Several study programmes are implemented in English

Study process and learning outcomes	· In recent years, RTU and the study field in general have demonstrated the ability to provide study courses in on-site, remote, modular and hybrid mode; · Constant demand for professionals in computer science and ICT, as well as for innovation and technology transfer in engineering; · Active Methodological Committees have been established at the faculties implementing the study field, which include the heads of all study programmes and student representatives.

Challenges	
Human resources	· Renewal of academic staff and general lack of real competition for the vacancies in the EU engineering sector; · Difficulties in attracting new members of academic personnel due to limited funding; · Balanced use of the existing human resources, avoiding duplication and balancing the academic and research work of the educators; · Continuous improvement of the knowledge of academic staff in both technologies relevant for the field and pedagogical approaches, following the industry developments.
Curriculum	· Raising the topicality of the themes of students' graduation papers and their quality in cooperation with the companies in the industry; · Closer integration of the curriculum and the research areas of particular academic units implementing the study programmes; · The curriculum of the study programme should be developed responding to the scientific advancements in the field. If the industry is at a low level of technological development, the study process also starts stagnating.
Study process and learning outcomes	· Introduction of a comprehensive student-centered approach (admission, individual plans, alignment, choice); · There is a noticeable tendency that the number of graduates who are willing to continue their studies in the higher education cycle (Master and PhD) is decreasing. · Professionalization of the study process management; · Academic environment that does not promote student engagement, which is characteristic of Latvia as a whole; · Insufficient funding does not allow expanding student involvement in the scientific research projects; · Reduction of student drop-out by introducing a mechanism for determining the reasons for drop-out.

External Factors

Opportunities

Local applicants	· Stable labor market demand for ICT specialists, which in general promotes and motivates applicants to commence studies in computer science and ICT-related fields; · There is a growing demand for the students with a Master degree in innovative enterprises; · Improvement of the study environment conditioned by the fact that the study process in carried out in a new building / premises facilitates attraction of students.
Foreign applicants	· Attraction of foreign students allows receiving additional funding as well as facilitates the professional advancement of academic staff; · In recent years, a relatively stable growth of the number of foreign students has been observed.
Further education	· High demand for lifelong learning courses partly funded by the state or other external funders (including industry); · Opportunities to develop internationally competitive further education and lifelong learning study courses in the competence areas of the study field; · General competence development projects implemented by RTU in cooperation with the companies on the local scale.
External cooperation	· Start of collaboration with MIT for credit point recognition and a cooperation agreement with the University at Buffalo; · Internal cooperation within RTU in the development of new interdisciplinary study programmes and implementation of interdisciplinary research, with the potential to attract also students, entrepreneurs, and researchers from external organizations; · Promoting the mobility of students and educators within the EUt + cooperation network; · RTU joint participation in the “European Network for Academic Integrity”, which allows developing both educator and student awareness about academic integrity and promoting honest study process; · A developed industry with great potential at the national level.

Competition	· Successful promotion of computer science and ICT by the industry helps attract students; · The image of RTU and the study field has been consistently positive for many years, as evidenced by entrepreneur and student surveys; · Successful communication about the digitalization of the study process and integration of modern trends in the curriculum allows successfully competing on the Latvian scale; · The offered study content is closely connected with the industrial environment, while several competitors in the Baltics still offer a classical mathematics-based university education in computer science and ICT; · A more diverse study programme offer compared to competitors is provided, ranging from software application to equipment development; · Request for high quality posed by the students, digitalization of the study process and transfer of best practices within international cooperation can be considered competitive advantages of the study field competitiveness; · Use of English as the language of instruction in the implementation of many study programmes strengthens their competitiveness not only locally but also internationally.
Legal framework	· Possibilities to streamline study programme and study field administration process; · Changes in the requirements of occupational standards to stop differentiating between academic and professional study programmes.

Threats	
Local applicants	· Problems in attracting students, especially to the Master and PhD studies, because employment trends in the sector do not offer students better career development opportunities or higher remuneration if a higher level of education is obtained. The industry is satisfied with the graduates with the general level of preparedness and opts to further train specialists according to the needed areas of specialization themselves; · Poor knowledge of mathematics and physics and poor awareness of the study process, and consequent inability to independently organize one's own study process; · Applicants have inaccurate perception of computer science and ICT - facing the need for acquiring significant knowledge of mathematics and physics, they lose motivation to study; · Unfavorable demographic situation, resulting in the reduction of the number of local students who can be attracted for studies, thus creating competition among the study programmes within the study field and with the study programmes implemented by other organizational units and even among universities; · A large number of students are employed full-time; · Volatile state and MES policies in the field of funding to higher education and science, which does not promote the growth of the proportion of young academic staff with a PhD degree.

Foreign applicants	· Different levels of preparedness of foreign students enrolling for studies
Further education	· Ability to provide and adapt development of specific skills to the specifics of each company operations with regard to the used software; · Lack of demand from the companies due to their willingness to educate and train the necessary specialists within the company.
External cooperation	· Low use of mobility opportunities by the research staff and PhD students, as well as insufficient involvement of guest lecturers and researchers from abroad; · Industry in general plays a passive role in the academic processes, as it itself is undergoing the process of transformation; · Weak strategic, political, information and financial support for higher education in Latvia as a whole.
Competition	· Lack of pedagogical capacity among the existing academic staff - pedagogical practice, choice of applied methods, ability to work with the audiences of different scale, as well as the knowledge and competence in their field; · Lack of competition for the announced academic staff positions; · Growing competition with the Latvian higher education institutions and foreign universities that implement study programmes in the field of computer science and information technology
Legal framework	· Complexity of the study process administration, if regulations on the further use of occupational standards in the broader context than previously are adopted; · Stagnant external regulation on the allocation of study funding, which in general does not promote the improvement of the study process.

The development of the study direction development plan was based on the results of the SWOT analysis, which made it possible to identify specific activities. A working group was formed for the development of the activity plan, which mainly included study program directors who are personally responsible for the implementation of the activities. According to the goals and tasks of the study direction and individual study programs, as well as the results of the SWOT analysis, an initial set of activities was created, which was improved through discussions within the Study Direction Commission. It should be emphasized that the development activities are coordinated with the development strategies of RTU and the faculties involved in the implementation of the study direction, thereby supporting and supplementing them. A summary of the development activities of the study field is provided below.

Consolidation of the study field

The main emphasis is made on reducing the proliferation of the study programmes and study courses. This would allow concentrating the existing resources and improving the quality. Activities to reduce proliferation:

- to review the offer of non-viable or stagnant study programmes with a view to modernize or close them, thus reducing the fragmentation of resources available for the study field;
- to reduce the proliferation of the study courses with the aim to improve the sharing of resources between faculties and to reduce fragmentation. The main attention should be paid

to consolidating and improving the curriculum of study courses similar in terms of content and scope;

- to start merging the study courses into larger ones in order to reduce the number of study courses amounting to 2CP – 3CP, i.e., to move towards maintaining the study courses in the volume of not less than 4 CP including practical classes. Thus, several aims will be achieved – the proliferation and fragmentation of courses will decrease, the courses will be more interesting for the students, and the existing resources will be used more efficiently.

Increasing the number of students in post-graduate education

The main aim of these activities is to ensure a significantly higher number of students who successfully complete an academic or professional Bachelor education cycle and start the next education cycle. As a result of the situation analysis, it has been determined that the main reasons for the lack of motivation among students are that the curriculum and study quality do not match student expectations (not always due to the low quality or deficiencies in the curriculum), lack of flexibility of study scheduling, and infrastructure which is not in compliance with the modern trends. Key activities to eliminate these shortcomings:

- Motivation mechanisms and internal organizational measures will be implemented to encourage the academic staff to undertake internship at the leading EU and North American universities for at least one semester. This will increase the professional qualification of the academic staff, as well as ensure better feedback regarding the educators in general.
- Attracting foreign guest lecturers will be promoted in order to provide students with knowledge and skills in the modern fields, thus improving student motivation to continue their studies, as well as creating a positive impression concerning the compliance of the curricula of the study programmes within the study field with the technological and scientific development trends. At present, the possibilities for attracting foreign academic staff to the relevant fields of study and science on the basis of independent employment contracts are being considered.
- Following the pattern of the existing study courses (Engineering Mathematics, Fundamentals of Programming, Fundamentals of Artificial Intelligence), a number of MOOC courses will be developed to ensure scalability and efficient resource use. This way, academic staff are given the opportunity to focus more on cooperation with the students rather than on providing the students with the study materials.
- The funding and opportunities available within the framework of Latvia’s digitalization initiatives will be used to include modern study courses in terms of their curriculum and teaching methodology in the existing study programmes. Digital transformation projects under the Digital Europe programme and economic recovery will play an important role (RSFF, https://likumi.lv/ta/id/324715-par-digitalas-transformacijas-pamatnostadnem-20212027-gadam)(only in Latvian).

Lifelong learning and retraining of the labor force

The activities focus on the development of lifelong learning and further education opportunities offered within the study field, using the advantages provided by the digital content to increase the number of students in lifelong learning. External funding available within various lifelong learning programmes, such as the Latvian national and EC co-financed programme framework, will be used as an important stimulus for development. At the time of writing of this report, the faculties involved in the implementation of the study programmes within the study field have been very active in attracting lifelong learning students – about 1,500 students a year. This allows attracting additional funding and achieving the strategic aims of the study field – to support and promote the national digital transformation agenda.

The development plan of the study field for the next period is given in the respective Annex *P13_2.1.2_Study_field_development_plan_2022-2027.pdf*.

2.1.3. The structure of the management of the study field and the relevant study programmes, and the analysis and assessment of the efficiency thereof, including the assessment of the role of the head of the study field and the heads of the study programmes, their responsibilities, and the cooperation with other heads of the study programmes, as well as the assessment of the support by the administrative and technical staff of the higher education institution/ college provided within the study field.

Internal quality control at the level of the faculty and study field is ensured by the faculty Deputy Dean for Academic Affairs. The quality of the study programme is ensured by the head of the study programme and the academic staff implementing the study program, who are supervised by the administration of the respective institute or department. Annotations of the study courses within the study programme and syllabi of the study courses, methodological materials, the newest study literature and methodological guidelines for development of the study papers (reports, study papers, internship reports and graduation papers) are reviewed once per academic year. The academic staff and the administration of the study programme participate in various experience exchange events, cooperating with the universities from other countries, meeting with the representatives of relevant institutions and entrepreneurs, as well as discussing current issues in the field, student research works and projects, analyzing their results.

The responsibilities and duties of the head of the study programme are described in the job description of the head of the study program. The most important of them are: management of study programmne design, improvement of study programme curriculum in accordance with the requirements of the field of science or the national economy, quality assurance of study programme implementation, supervision of study plan development, promotion of internationalization, cooperation with RTU Study Department, ensuring the entry of data in the information system, as well as with the organizational units of the University involved in the implementation of the study program. The administration of the faculty constantly monitors the compliance of the premises and technical equipment with the modern quality requirements. Appropriate study premises have been created that are equipped with the necessary multimedia facilities. Support functions for the development and implementation of the study programmes at RTU are provided by the Study Department. The Programme Management and Curriculum Design Unit plays an important role in providing support in the improvement of the study programmes.

RTU has established a resilient system for the governance and improvement of the study programmes. Proposals for the changes in the study programmes are developed by the Study Field Committee based on the recommendations of the academic staff, feedback from employers, student self-government, as well as considering the latest trends in the national economy and labor market. The Study Field Committee addresses the faculty councils to review and approve the changes. Based on the decision of the council, changes in the study field are suggested, which are further approved by the RTU Senate. Changes in the structure of the study programmes are approved by the order of RTU Vice-Rector for Academic Affairs. The technical support of the study field is provided by the study programme record keeping unit and the IT service. Such cooperation in the implementation of the study programmes within the study field can be considered effective and promoting the overall development of the study field.

The most essential aspects of governance are listed below:

- The study field is generally managed by the Study Field Committee, which consists of the heads of the study programmes, industry representatives, leading members of academic staff, representatives of the students' self-government and the deputy head of the study field. The Study Field Committee is headed by the head of the study field. Both the head and the deputy head of the study field are approved by the RTU Senate.
- The heads of the respective study programmes are responsible for the implementation and development of the study programmes in the study field, they also ensure daily cooperation with the students, graduates and representatives of the respective industry. The head is responsible for considering the received recommendations, complaint treatment procedures, and achieving the aims of the study program.
- Changes in the study field are first considered at the corresponding organizational unit (departments and institutes). Depending on the nature of the changes, they are also considered by the Study Field Committee. After reviewing and approving the suggested changes, they may be channeled to the faculty councils for consideration. According to internal regulations of RTU, certain types of significant changes are coordinated in the RTU Senate.

The current governance system provides an opportunity for all stakeholders to influence the improvement and development of the study field both by submitting proposals for specific changes and by actively working on considering other proposals. Industry makes an important contribution to this process; industry representatives may use the existing system to promote compliance to and satisfaction of the industry needs.

Meetings of the Study Field Committee are also convened in cases where there are suspicions of significant non-compliance with good practice or quality requirements. In such cases, the issues are considered on the basis of the case reports of all parties involved, but the decisions taken are binding for the implementers of the study programme (departments and academic staff). Meetings of the Study Field Committee are organized either in person or remotely. A voting mechanism is used to make decisions and approve or reject proposals.

The study field governance system is depicted in the respective Annex *P14_2.1.3_RTU_Study_Direction_Management_Structure_ENG.pdf.*

2.1.4. Description and assessment of the requirements and the system for the admission of students by specifying, inter alia, the regulatory framework of the admission procedures and requirements. The assessment of options for the students to have their study period, professional experience, and the previously acquired formal and non-formal education recognised within the study field by providing specific examples of the application of these procedures.

The admission process and procedure of students' matriculation is stipulated in the RTU Admission Regulations, which are elaborated based on the Law on Higher Education Institutions and Regulations of the Cabinet of Ministers No 846 of 10 October 2006 "Regulations on the Requirements, Criteria and Procedures for Enrolment in Study Programmes", as well as the specific requirements of study programmes and the industry. The RTU Admission Regulations are approved by the RTU Senate and published on November 1 each year (see the files of Annex 29-35 of the List of Internal Regulations).

Admission requirements are logical, understandable, and linked to the goals defined in the RTU Strategy. Admission system is state-of-the-art, easily accessible, logically structured, and is evolving in line with modern digitalization trends, providing the potential students with the convenient and user-friendly university application tool.

Applicants are admitted to full-time and part-time undergraduate programmes based on the results of the Centralized Examinations (CE) in Mathematics, the Latvian language and the foreign language, and the final grades in individual subjects obtained in the secondary education, and the entry test results. If, in addition to these CEs, the applicant has a CE in Physics or Chemistry, the results of these CEs are taken into account in the calculation of the ranking.

In order to participate in the competition for the state budget funded seats, the rating in Mathematics CE is calculated as the average value of all Mathematics CE rating sections and must be at least 15 percent. An applicant with a CE in mathematics of less than 15 percent may get enrolled only for a tuition fee. Until 2022, the minimum CE value was 12%.

To determine the candidate’s rank in the competition, each CE rating, calculated as an average of all CE evaluation sections, and each entry test (if any applies) is multiplied by the appropriate weighting factor and the resulting multiplications are added together. Some study programme applicants must pass an entry test, the result of which shall be multiplied by an appropriate weighting factor and summed up in the total calculation of the rank.

The persons, who have received secondary education prior to 2009 (including), as well as persons, who have received secondary education abroad, or persons, who were exempted from passing the secondary education state examinations in accordance with the procedure set by the regulatory enactments, may be admitted to the study programmes based on their year grades in the secondary education document in the subjects mentioned in the RTU Admission Regulations, which must be successfully passed. Up to 2019, the admission based on the secondary education year grades was attributed to persons who completed secondary education prior to 2004. In general, the RTU Admission Regulations follow the Cabinet Regulations No 846.

Persons who have completed secondary education and have not passed any of the CEs mentioned in the RTU Admission Regulations or have failed the year grade, shall pass the CE in accordance with Cabinet Regulations No 335 of 6 April 2010 “Regulations Regarding the Content and Procedures of Centralized Examinations”.

Persons who have not passed the CE in Latvian and who do not meet the requirements of RTU Admission Regulations, shall pass the entrance examination in Latvian as prescribed by RTU. The result is evaluated as percentage.

In compliance with Cabinet Regulations No 543 adopted on 29 September 2015 “Regulations on Replacement of the Foreign Language Centralized Examination in the General Secondary Education Programme by Foreign Language Examinations Conducted by International Testing Institutions”, CE in the foreign language can be replaced with a foreign language examination conducted by an international testing institution the certificate of which must be presented to the RTU Admission Committee.

The applicants who have acquired a Bachelor degree in a field relevant to the study programme are enrolled to the post-graduate study programmes. The applicants take part in the competition with a weighted average grade from the Bachelor or professional study programme records. The weighted average grade is calculated as the sum of all the grades received in each study course multiplied by the credit points acquired in the study programme and is divided by the total number of credit points within the study program. If credit points are not identified, the number is calculated as the multiplication of the grades and contact hours obtained in each study course divided by the total number of contact hours.

Before applying for the PhD studies, the candidate and the Head of the PhD Study Programme must agree upon the possible scientific advisor/consultant and receive their written consent. The scientific advisor to the PhD Thesis may be from another scientific establishment; however, the applicant must also choose the scientific advisor/consultant from RTU. Every year, the RTU Senate approves the regulations for the admission of PhD students for the academic year, which set deadlines for the submission of admission documents. The applicants for PhD study programmes can submit application for full-time studies by arriving at the Doctoral Studies Department, bringing the required documents, within the admission deadlines. Documents necessary for the competition are compiled by RTU Doctoral Studies Department. After the collection of documents, the Doctoral Studies Department submits them to the Scientific Committee of the respective Faculty, which draws the ranking tables of the applicants according to the evaluation criteria set by the Scientific Committee of the Faculty and approved by the order of RTU Vice-Rector for Research. The ranking tables are submitted to the PhD Admission Committee. The composition of the PhD Admission Committee is approved by an order of RTU Vice-Rector for Research.

Taking into account the spread of Covid-19 and in order to facilitate the admission process of applicants for studies at RTU, starting from the summer of 2020, the admission process for undergraduate and post-graduate study programmes was improved.

There are two ways to apply for the state budget funded seats at the undergraduate study programmes:

- Electronically in the Joint Enrolment Undergraduate Study Programme Information System, using the e-service portal (https://www.latvija.lv). Given the spread of Covid-19, starting with the summer 2020 admission, secondary school graduates of the 2019/2020 school year can approve the electronic application remotely without arriving in person. If the secondary education was obtained abroad or until 2019/2020 school year, the applicants must confirm their electronic applications by arriving at the designated locations within the deadlines and presenting the originals of the required documents;
- Arriving at the RTU Admission Committee in person, presenting the originals of the required documents.

To apply for the competition for the state budget funded seats in the post-graduate study programmes RTU undergraduate study programme graduates can submit their applications online on RTU portal ORTUS.

Taking into account the spread of Covid-19, starting with the summer 2020 admission, also graduates of undergraduate study programmes implemented by other Latvian state-accredited higher education institutions can submit applications electronically on the RTU website, or by visiting RTU Admission Committee.

Applicants who do not qualify for the state budget funded seats and applicants who have received their education outside Latvia, as well as in other specific cases, must appear in person at the RTU Admission Committee within the admission deadline, with the required documents.

In view of the spread of Covid-19, and in order to improve the admission process at RTU and to facilitate the application of entrants for studies at RTU, electronic application for tuition fee funded studies at undergraduate and post-graduate study programmes were introduced in summer 2021.

Recognition of previously acquired formal and non-formal education at RTU is carried out in accordance with the "Regulation on the Recognition of the Courses Completed at Other Universities and RTU Study Programmes" (Resolution of RTU Vice-Rector for Academic Affairs No 02000-1.1/29 as of 4 April 2016) and the "Procedure for Recognition of Competencies Developed Outside Formal Education or From Professional Experience and Learning Outcomes Achieved in Previous Education at Riga Technical University" (approved at the Meeting of RTU Senate on 23 September 2019, Minutes No 632) (see https://international.rtu.lv/wp-content/uploads/sites/65/2021/02/09.-Procedure_for_Recognition_of_Competencies_Developed_Outside_Formal_Education.pdf and in the file of Annex 09 List of Internal Regulations).

RTU Admission Regulations are published at https://www.rtu.lv/lv/studijas/uznemsana/uznemsanas-noteikumi (for local students) and at http://fsd.rtu.lv/ (for foreign and exchange students).

Credentials on the possibilities to continue studies and provision of the compensation for losses to students in case the study programme terminates are attached in the Annex, as well as a standard sample of the study agreement.

2.1.5. Assessment of the methods and procedures for the evaluation of students' achievements, as well as the principles of their selection and the analysis of the compliance of the evaluation methods and procedures with the aims of the study programmes and the needs of the students.

Assessment of student learning outcomes is carried out in accordance with the "Regulation on the Assessment of Learning Outcomes" (approved at the Meeting of RTU Senate on 27 May 2017, Minutes No 610), which is available on Studies Regulations page of RTU web page (https://international.rtu.lv/wp-content/uploads/sites/65/2021/02/04.-Regulation_on_the_Assessment_of_Learning_Outcomes.docx.pdf (attached also in Annex 04 in the List of Internal Regulations). Summative assessment system is used in appraisal of student achievements, it implies that the final grade is composed of numerous components.

In the study course descriptions of the study programme there is a set of relevant knowledge, skills and competences and their evaluation system, defined learning outcomes for the achievement of which credit points are awarded.

Pedagogical methods used in the implementation of study courses, as well as assessment forms and methods are selected by the instructors responsible for the study courses in compliance with course curriculum and specifics of the program, as well as student needs. A member of academic staff should inform students about particular assessment criteria at the fist lecture/practical class. The main advantage of the summative assessment system is that the final grade is made up of several components. Therefore, the students may contribute to their final grade working during semester.

Criteria for assessmentof the study courses and individual/home tasks are published on ORTUS e-study system beforehand. During semester, the assessment for each home task, test, report, presentation and any other task is ascribed certain weight in the final grade. Exam grade may not exceed 50% of the final grade. Academic staff may take into consideration and also assess student attendance and their activity during the classes. Assessment structure for the study course is determined by the academic staff themselves, abiding the resolution of RTU Senate that the exam grade may not contribute more than 50% to the final grade. Selecting assessment criteria and methods for evaluation of student achievements, specifics of each study programme and learning outcomes are taken into consideration.

In order to advance professional pedagogical competences of the academic staff, courses and seminars on the newest pedagogical methods are organized regularly. Qualification advancement is provided at both the University and faculty level, organizing academic conferences and methodological seminars. The Centre for Academic Excellence has been established and successfully operates at RTU; it organizes various events aimed at professional advancement of academic personnel at the University level.

(In addition, see the description of each study programme).

2.1.6. Description and assessment of the academic integrity principles, the mechanisms for compliance with these principles, and the way in which the stakeholders are informed. Specify the plagiarism detection tools used by providing examples of the use of these tools and mechanisms.

Since 2010 all students that gradate from any RTU study programme should upload electronic versions of their graduation papers in ORTUS portal in order to improve the quality of graduation papers, create a bibliographic database of the graduation papers and introduce an automated control system for detecting plagiarism. RTU uses two major plagiarism control tools in the study process:

1. Since 2015, graduation papers of study programmes in the study field have been checked in the joint computerized plagiarism control system (JCPCS), which unites numerous Latvian universities and colleges. RTU uses the system in cooperation with the University of Latvia. This system is used to check graduation papers after their uploading to the ORTUS environment. JCPCS complements and extends plagiarism identification opportunities.
2. Starting from 20 December 2017, RTU has been running TurnitIn®, the world's leading tool for the correction of written papers and aversion of plagiarism that is used daily by millions of students and academics around the world. TurnitIn® tool is integrated with RTU ORTUS e-study system and provides full service of submitting, correcting, verifying the originality (plagiarism) and return of the submitted papers. TurnitIn® offers two main platforms: a platform that automatically checks for the percentage of non-genuine content (plagiarism) and allows to electronically correct the submitted papers. This tool is used to check all the electronic versions of graduation papers submitted for defence and further control measures are operatively implemented for potential plagiarism detection.
3. At the FSCIT, an in-house designed and developed plagiarism detection tool is used, which allows detecting cases of plagiarism with high accuracy, taking into account different languages and different methods of concealment, including the use of synonyms and paraphrasing tools. The tool is mainly used for checking graduation papers. It is also integrated into the governance processes of individual study courses. Depending on the type and extent of plagiarism, a committee is set up to review such cases and make decisions in accordance with the effective RTU regulations.

Graduation papers are checked in both systems in parallel, thus using the advantages of both systems. The developed PhD Theses are controlled with extreme scrutiny in a similar manner. Since

2005, the Code of Ethics of RTU Students, Academic Personnel and Staff has been effective at RTU (see the file of Appendix 19 of the List of Internal regulations). The Code of Academic Integrity was approved at the RTU Senate meeting of 29 February 2016. The aim of the Code of Academic Integrity is to strengthen academic culture and integrity in the academic environment of RTU, to explain the concept of academic integrity and related actions, to define main procedures in examination of academic fairness violations. (see https://www.rtu.lv/writable/public_files/RTU_rtu_studiju_reglaments_7.1.1.4..pdf (only in Latvian) and attached in File 38 of the List of Internal Regulations).

There are procedures defined how the report on the violation of the student's academic integrity is filled, registered, reviewed, and appealed. Informing and educating students about the aspects of academic integrity takes place both within the study courses and in the specially organized seminars.

Both students and academic staff have access to the book "Glossary for Academic Integrity. General Academic Integrity Guidelines" published by RTU publishing house (available at https://ebooks.rtu.lv/product/akademiska-godiguma-terminu-vardnica-akademiska-godiguma-vispar ejas-vadlinijas/ and http://www.academicintegrity.eu/wp/glossary/).

In addition, RTU participates in different initiatives that bring forward and solve academic integrity related issues. RTU is a member and one of the founders of the European Network for Academic Integrity (ENAI), where it is involved in active experience sharing, keeping updated about academic integrity related issues, and organizing conferences. The Dictionary of Academic Integrity Terms and Guidelines is one of the newest aids that has been developed and published by RTU Press. In the framework of Specific Support Objective (SSO) 8.2.3 of the project "Development of Efficient Governance of Riga Technical University", RTU, in cooperation with the University of Latvia (UL) and Rīga Stradiņš University, develops educational aids, as well as participates in the establishment of the Latvian national academic integrity organization and development of plagiarism control tools.

The organizational units implementing the study programme have developed a control mechanism, i.e., the initial check is performed in the process of interim assessment, which is performed by the work of the Advisory Examination Commission. When students come to these examinations, they should submit the electronic version of the performed work and the paper is checked in free plagiarism control tools in presence of the student. When students draft their graduation papers, they are instructed about plagiarism and its consequences several times.

Methodological materials contain detailed instructions on correct presentation of references. This process allows reducing plagiarism and highlighting faults in the student's paper, which needs to be rectified. The generally accepted "good practices" show that more attention should be paid to the papers showing 20 percent or more matches. A message is received from the system, when the match level is higher than 20%. The papers are examined, reasons for the matches in the text are evaluated and a decision is made whether the student should be allowed to defend their graduation papers.

As mentioned above, within the study direction, the tools of academic integrity control software developed by RTU are used. The example reports of this tool for specific cases can be found in the attached annex *2.1.6_AkadGodigumsRiks_LV_AcademicIntegrityTool_ENG.pdf*.

The tool provides both an overview to assess the extent of the breach of academic integrity and draws attention to specific sections of the paper to ensure that the use of external sources is justified and properly referenced. Thus, the student has the opportunity to provide an explanation or even appeal against the decision. It requires presenting the evidence by both the administration of the study programme and the student.

2.2. Efficiency of the Internal Quality Assurance System

2.2.1. Assessment of the efficiency of the internal quality assurance system within the study field by specifying the measures undertaken to achieve the aims and outcomes of the study programmes and to ensure continuous improvement, development, and efficient performance of the study field and the relevant study programmes.

RTU operates pursuant to the “Constitution of Riga Technical University” (approved by the Law “On the Constitution of Riga Technical University”, the law was adopted in the Parliament on 23 October 2014 (see the file of Annex 01 of the List of Internal Regulations).

In order to efficiently control implementation of RTU Strategy, RTU Strategy Management System has been established, which provides that strategic aims, activities and tasks are cascaded to the level of definite organizational units and their staff.

RTU has *an internal quality management system* in place in accordance with the RTU Quality Policy updated and approved at the meeting of RTU Senate on 25 September 2017, Minutes No 612 (see: RTU Quality Policy) and the RTU Excellence Approach approved at the meeting of RTU Senate on 30 January 2017, Minutes No 606 (see: RTU Excellence Approach). Since the study field is one out of 12 study fields implemented by RTU, and its internal quality system is closely related to RTU Quality Management System.

RTU Quality Policy is aimed at implementation of RTU mission and achievement of strategic aims – reaching excellence in scientific research, academic, infrastructure and organizational excellence, and recognizability. The Quality Policy provides the framework for implementation of RTU Strategy, and the paths for development and improvement of research, study process and organization. RTU Quality Policy is reconciled with the ENQA standards and guidelines. RTU Excellence Approach and Quality Policy are reciprocally integrated documents, which determine that RTU employs the EFQM quality model.

Since December 2018, RTU has been a member of the European Foundation for Quality Management, having joined the global quality cooperation network.

RTU Excellence Approach (see the figure in file “RTU Excellence Approach”) has been elaborated in order to promote purposeful development of the University as an excellent organization, and RTU Constitution, Strategy and Quality Policy are integrated therein; it is based on the *Standards and Guidelines for Quality Assurance in European Higher Education Area (ESG)* developed by the European Association for Quality Assurance in Higher Education and the basic principles of the *EFQM* Excellence Model.

The structure of RTU Excellence Approach (see the figure in file “Structure of RTU Excellence Approach”) is designed in accordance with the criteria of the EFQM Excellence Model and forms the basis for the maintenance of performance at a high level, a prerequisite for its continuous improvement, as well as for achievement of sustainable results of RTU activities and excellence. Student results are a separate criterion, they are also in part transferred to the main activity results; thus, the quality of the study field is closely related to RTU quality management.

To promote introduction of the model of the EFQM total quality management system, as well as to assist in the compilation of a self-assessment report, a working group was established at RTU on 29

September 2017 (Rector's order No 01000-1.1/225), which comprises representatives of RTU administration, faculties and Student Parliament (18 in total).

Potential problems were identified and suggestions for improvement of RTU Quality Policy, including the improvement of academic quality, were made at the meetings of the working group. In the period of one year, the working group considered compliance to nine criteria of the EFQM model and analyzed 101 sub-criteria, having identified 133 problems in total and having made 146 suggestions. The priority problems were included in RTU Development Plan as tasks set for a definite term to be solved by the respective organizational units. Quality model review report is drawn up with regard to the Quality System, which identifies the areas that should be improved. Performance indicators and results of student polling are integrated in RTU Quality System.

Application of RTU Excellence Approach is based on process-oriented activities and includes clear process flow and their interaction. Striving for excellence, RTU actively works on process planning, definition of its aims and interaction analysis. RTU has developed criteria and methods for ensuring efficient process operation and management. RTU conducts the process analysis and provides recommendations and suggestions on process improvement, which are discussed with process managers and persons responsible for process procedures; later they are approved as performable tasks with a definite completion term. Task creation and control tools inbuilt in the Document System, reports on task performance at the organizational unit level provide the necessary support for achievement of performance indicators of the annual aims and tasks set in RTU Strategy. For example, development of the uniform study programme application structure and assessment criteria was one of the tasks for the process "Provision and Organization of Studies" approved in the system with the completion term set until 31 December 2020; they were developed and approbated on the study programmes developed within SSO 8.2.1 project.

The departments and institutes, faculty councils, the Office of the Vice-Rector for Academic Affairs, the Office of the Vice-Rector for Development, the Student Parliament and the RTU Senate are involved in ensuring internal quality of studies at RTU. These institutions comprehensively evaluate the newly created study fields and programmes, as well as changes to study fields and programmes, evaluate annual self-assessment reports of the study fields. The internal quality assurance mechanism controlling the quality of studies at RTU is functioning at the level of administration, faculties, study fields and study programmes.

Study Field Committees at RTU supervise academic activities in the respective study field and are responsible for the curricula of the study programmes within the study field, including accreditation of the study field. Members of student self-government are involved in ensuring the quality of the study field and study programmes implemented therein; they actively participate in the work of the decision-making bodies of the University: RTU Constitutional Assembly, RTU Senate, RTU Senate committees and faculty councils.

Several faculties and their administration are involved in the quality management of the study field. The Study Field Committee and the head of the study field play a decisive role in the process of internal quality assurance. Faculty councils of the FCSIT, FET and FETH, heads of the study programmes, institutes and departments implementing the study program, as well as faculty student self-governments and methodological committees are involved in quality assurance. The heads of the study programmes and Faculty Deputy Deans for Academic Affairs ensure academic quality control in the course of daily activities.

The study programmes implemented within the study field are regularly evaluated, as a result, an overview of the study field improvement is provided (https://www.rtu.lv/lv/universitate/dokumenti/studiju-virzienu-ikgadejie-parskati) (only in Latvian). In order to ensure a qualitative evaluation of the study programmes, from 4 to 6 people representing all three faculties implementing the study programmes in the study field, study programmes and students participate in the drafting of the report. (Self-assessment reports used to be submitted until 2018 (only in Latvian)).

Persons involved in the preparation of the self-assessment report required for the study field evaluation procedure (reporting period 2013-2022): 1) the director of the study field, who is responsible mainly for the preparation of description of the study field, for the development strategy and plan of the study field, and for the preparation of the corresponding appendices (sections 1 and 2 of the report); 2) the directors of the study programmes, who are responsible for the preparation of description of the study programmes included in the study field, also for the development plan and for the preparation of the corresponding appendices (section 3 of the report); 3) students whose contribution to the development of the study field and specific programmes has been reflected in the programme improvement activities carried out during the reporting period.

The director of the study field and the directors of the study programmes, as necessary, involve the necessary academic or administrative staff, as well as representatives of the field (for example, to update the professional standards) in the development of the self-assessment report. Remote meetings (at least eight during the active phase of the preparation of the document) were held to to discuss and find solutions for the various issues that arose during the preparation of the self-assessment report. In these meetings participated all employees involved in the preparation of self-assessment report of the study field. During the meetings, within the certain period of time noticed or re-merged problems were identified. All parties were involved in the search for solutions to these problems. Individual programme needs were taken into account in the context of the overall view of the study field.

In order to prepare the self-assessment report with appropriate annexes and to ensure more effective communication between the participants in the working group, the MS Teams Project group was created, where all the documents related to the development of the report were stored, for common and simultaneous use and processing.

Irrespective of the preparation of the study field improvement report (which was until 2018) and the study field self-assessment report (for the reporting period 2013 - 2022), study field improvement activities are performed, the most significant of which are:

- Curriculum Design and Testing Committee of FCSIT put forward the issue concerning consideration of the instances of breach of academic integrity “On the Procedure for Reviewing the Cases of Plagiarism in Students’ Graduation Papers at RTU Faculty of Computer Science and Information Technology” (approved at the meeting of FCSIT Council on 14 June 2019, Minutes No 12000-1.1/9).
- Curriculum Design and Testing Committee of FCSIT put forward the issue concerning the formatting of the graduation papers and minimum requirements towards their content. The heads of the study programmes and the heads of the departments implementing the study courses were involved in the development of the guidelines. “The Formatting and Style Guidelines for Graduation Papers (in Latvian and English)” were developed to unify the requirements set at different study programmes, thus ensuring the same high quality of graduation papers in all programmes (approved at the meeting of FCSIT Council on 18 October 2021, Minutes No 12000-1.1/10).
- Curriculum Design and Testing Committee of FCSIT put forward the issue concerning graduation paper development process and planning of various activities, including the preliminary viva voce. The document is intended to organize the internal processes in order to promote the continuity of the process of graduation paper development and their quality

to the degree possible. “Unified Procedure for Bachelor Paper Development in the Academic Study Programmes at the RTU Faculty of Computer Science and Information Technology” (approved at the meeting of FCSIT Council on 13 December 2021, Minutes No 12000-1.1/13).

- Curriculum Design and Testing Committee of FCSIT put forward the issue concerning the rotation competition for the state budget funded seats in order to develop a mechanism stimulating students to obtain state budget funding for studies. “Regulation on the Rotation Competition for Study Seats Subsidized from the State Budget at the Faculty of Computer Science and Information Technology” (approved at the meeting of FCSIT Council on 20 March 2020, Minutes No 12000-1.1/5).
- The Department of Radio Equipment of the FET Institute of Radio Electronics considered the “Regulations on Internship at the Professional Master Study Programme ‘Smart Electronic Systems’” (approved at the Department meeting on 6 July 2021).
- FET developed the “Guidelines for Formatting the Graduation Papers”.
- Curriculum Design and Testing Committee of FETH considered and FETH Council approved (on 7 April 2021, Minutes No 80) “The Academic Research Student Handbook”. The Academic Research Student Handbook has been designed for the students of the academic Master study programme “Digital Humanities”, Faculty of E-Learning Technologies and Humanities, Riga Technical University, as the manual providing guidance on curricular and extracurricular academic research activities, focusing particularly on the development of the Master Thesis. The handbook has been crafted following best practices approved in the leading universities and taking into account the existing regulations of the Republic of Latvia and the internal documents of RTU on student research activities and development of the graduation papers. The book is intended for students, academic staff, scientific advisers and reviewers of graduate papers and the members of the final examination committees of the academic Master study programme “Digital Humanities”. The book is available at: https://ebooks.rtu.lv/product/academic-research-student-handbook-for-the-students-of-academic-master-study-programme-digital-humanities/ .
- "Regulation on the Rotation Competition for Study Seats Subsidized from the State or University Budget at the Faculty of E-Learning Technologies and Humanities of Riga Technical University” was considered at the meeting of FETH Council and approved by the Study Department on 30 June 2017.

2.2.2. Analysis and assessment of the system and the procedures for the development and review of the study programmes by providing specific examples of the review of the study programmes, the aims, and regularity, as well as the stakeholders and their responsibilities. If, during the reporting period, new study programmes have been developed within the study field, describe the procedures of their development (including the process of the approval of study programmes).

Study programme development and revision processes are regulated by the “Procedure for Application, Elaboration and Amendment of the Study Programmes” (published at https://www.rtu.lv/writable/public_files/RTU_studiju_reglaments_4.6._programmu_izstradasanas_kartiba_29.04.2019.pdf (in Latvian); also included in Annex 06 to the List of Internal Regulations), which in detail specifies activity sequence and parties involved, starting with drawing up an application for new study programme elaboration and finishing with study programme closure. The procedures are reconciled with the effective national regulatory enactments pertaining to the licensing and amendment of the study programmes.

Revision of the study programme curricula is the responsibility of the Study Field Committee. The responsibilities and activities of the committee are regulated by the "Regulation on the Study Field Committee" (approved by the RTU Senate on 26 April 2021, Minutes No 649; published at RTU_studiju_reglaments_4.7._studiju_virziena_komisijas_nolikums.pdf (only in Latvian); also included in Annex 07 to the List of Internal Regulations).

Expert assessment of the study programmes is performed by the Study Field Committee, then – by the Faculty Council or the councils of several faculties involved. The expert assessment procedure is finalized by the Study Department. The Study Field Committee evaluates the quality of the draft study programme and the compliance of its curriculum to the planned aims and tasks.

"Procedure for Application, Elaboration and Amendment of the Study Programmes" https://www.rtu.lv/writable/public_files/RTU_studiju_reglaments_4.6._programmu_izstradasanas_kartiba.pdf

"Regulation on the Study Field Committee" https://www.rtu.lv/writable/public_files/RTU_studiju_reglaments_4.7._studiju_virziena_komisijas_nolikums.pdf

"Regulation on Student Polling for Assessment of the Study Process" https://docs.rtu.lv/lds/document/doc/158314.

In the reporting period, several new study programmes have been launched, including:

- Academic Bachelor study programme "Computer Science and Organizational Technologies";
- Professional Bachelor study programme "Smart Electronic Systems";
- Academic Master study programme "Cybersecurity Engineering";
- Academic Master study programme "Digital Humanities";
- PhD study programme "Computer Science and Information Technology".

The study programme development process is relatively well regulated at RTU. First, the working groups are established. To establish a working group, it is necessary to obtain a decision of the council of the faculty that will implement the study program, which is based on the opinion/recommendation of the Study Field Committee. The Study Field Committee shall comprise industry representatives who are actively involved in the development of the study programme proposal in the matters related to its curriculum and implementation. In addition to the study programme application, the study programme applicant shall submit a justification to the Study Field Committee, which shall contain an appropriate assessment or recommendation from the industry, which in such a way expresses its support and justifies that there is a need for establishment of the study program. Support may be provided by professional organizations in the field, which get directly involved in the provision of the rationale and setting of the objectives of the study program.

Only once the above-mentioned processes are successfully completed, the drafting of the study programme documentation required for obtaining a license starts. The application documentation is also approved by the Study Field Committee, the councils of the relevant faculties and the RTU Senate, which endorses the working group to submit the programme application to the Quality Agency for Higher Education.

Thus, multiple revisions and refinements of the study programme are carried out, involving both the RTU administration and the organizational units implementing the study program, as well as industry representatives.

Study programme monitoring/revision is part of the continuous quality management process, the main goal of which is to ensure high quality of study programme implementation. Depending on the specific situation, the Direction Commission can make decisions about the study programme, its composition, form of implementation, etc. decisions. During the reporting period, in response to the analysis of student dynamics, a decision was made to close certain study programmes, and also, taking into account the industry's demand for the development of specific competencies, new study programmes were created, which are indicated above.

2.2.3. Description of the procedures and/or systems according to which the students are expected to submit complaints and proposals (except for the surveys to be conducted among the students). Specify whether and how the students have access to the information on the possibilities to submit complaints and proposals and how the outcomes of the examination of the complaints and proposals and the improvements of the study field and the relevant study programmes are communicated by providing the respective examples.

In order to promote continuous improvement of the quality of studies and provide students with the opportunity to submit proposals and complaints on various study-related issues in accordance with the ESG, in the reporting period from 2013 to mid-2019, at RTU, the analysis of students' recommendations and complaints was carried out; this was done by involving the organizational units to which the applications related, as well as the student self-government of the respective faculty.

A new document was approved in 2019 and now student complaints and proposals are considered in compliance with the "Procedure for Submission and Examination of RTU Students' Proposals and Complaints" (published at https://www.rtu.lv/en/university/proposals-and-complaints and available in the section "Other Annexes").

The Procedure stipulates how RTU students may submit suggestions and complaints concerning the study process and other issues and determines the terms for consideration of applications and provision of the response (if the applicant has provided one's contact information) and summary of application statistics.

A total of 43 complaints/proposals have been received between September 2021 and May 2022, none of which were submitted anonymously. Of the submissions, 32 were complaints and problems, and 11 were suggestions across six topics (subject: the number of complaints or problems / the number of proposals):

- Study process: 13 / 6
- IT issues: 9 / 2
- Maintenance of Infrastructure issues: 1 / 0
- Accomodation related: 3 / 0
- Foreign students' questions: 8 / 1
- Information flow: 2 / 0

Evaluating the submitted complaints about the study process, six of them are related to the unavailability of lecture schedules in the ORTUS e-learning environment, late posting of information on the final work and/or homework, often no links to connect to a specific lecture in a distance learning format. Four of the complaints and problems are related to the constraints of the Covid-19 pandemic. Complaints have been received that teachers do not attend classes or cancel very shortly before they take place. There are several complaints about specific lecturers and their work, about poor-quality lectures and in cases when several lecturers are involved in the implementation of the study course, there is no consistency about the requirements for students; there are no specific criteria for the final works. Complaints have been received that lectures take longer than indicated in the schedule, as well as students' health problems during the study process and final examinations are not considered. It is not clear to young students what to do next after signing the study agreement. Proposals have been received to organize certain study courses only in a remote format, as well as to be more flexible and to respect the free choice to obtain a vaccination certificate. The proposal is to move to a single remote lecture platform, where calendar-scheduled lectures can be automatically linked to the person's calendar, making it easier to notice changes when they occur. The opportunity to see the recipients of their course scholarships and their success could increase the competition and motivation of other course students.

The economic sector has received a complaint about the lack of heating and hot water in some faculty. Student hostels have several complaints about poor sound insulation and noise from neighbours at night. International students often disregard ethical and cleanliness standards, leaving unpleasant environment for the rest of the residents.

International students have asked for more support in the study process and provision of information in English, as well as to expand the possibilities of psychological support. A frequent complaint is about the length of time required to complete the documents in order to start studies and stay in Latvia. Complaints have been received that the schedule of lectures is often not available and, especially for the autumn semester, it becomes available delayed. Several complaints have been received about the attitude of teachers – they do not give access to course materials, regularly change the dates of exams and tests, do not indicate connection links to lectures, poor quality and indifferent study process, are often inaccessible and do not respond to students' e-mails. There has also been a complaint that Erasmus+ students do not have another European student on their course when they arrive to the university.

Complaints received about the exchange of information are mainly related to the lack of information at all or very late publication. RTU websites have outdated entries and are no longer relevant.

Five IT issues are related to the correction of the calendar study schedule. Complaints have been received that the newly introduced compulsory student e-mails edu.rtu.lv are not working, problems with accessing MS Office services through the ORTUS system. It is also not possible to access the RTU cloud, from which the student cannot receive materials for the study course. Suggestions have been made for creating a more convenient electronic scholarship form to make it easier for the user to transfer information with a copy function. The recommendation is to provide students with access to the Stimul8 programme, which could improve the study process.

At the level of faculty administrations and study programmes implemented within the study field, the processing of complaints and suggestions is aimed at solving the problem, to the degree possible averting the need for resolving to appeals and other formal mechanisms.

Definite examples are considered below:

No	Registration data	Short summary of the case

1.	A complaint submitted online via the RTU complaint submission system was registered on 4 September 2019	The complaint concerned the teaching methods used by a particular member of academic staff and inadequate study materials. The complaint was considered involving the Deputy Dean for Academic Affairs and the Head of the study programme “Computer Systems”. A plan for solving the problem was drawn up, informing the complainant on the resolution. The problem was resolved with no further administrative consideration.
2.	A complaint was submitted via e-mail on 2 December 2019, it was addressed to the Deputy Dean for Academic Affairs of FCSIT	A specific case of the use of inappropriate premises for the course “Systems Analysis and Knowledge Acquisition” due to the large number of students. An unsubstantiated attempt to impose sanctions on the students if they did not attend the end-of-semester classes was made. The problem was solved by equipping additional work stations in the above-mentioned classroom to provide the required number of work stations. No sanctions were imposed and the situation was discussed with the instructor, which allowed avoiding administrative escalation of the situation.
3.	A complaint was received on 2 March 2021 with regard to the delivery methods and curriculum of the study course “Special Electrical Machinery for Robotic Systems”	The head of the implementing department and the Dean of FEEE were informed about the situation, which allowed replacing the instructor. The change of instructor resolved the situation.
4.	An appeal was received on 14 June 2021 with regard to the violation of the graduation paper assessment procedure during the viva voce	With the order of FCSIT Dean, an Appeals Committee was established. After considering the situation and discussing the matter with the members of the Final Examination Committee, the Appeals Committee came to the conclusion that the procedure had been followed and no violations of the procedure or regulation were identified in the work of the Examination Committee.
5.	An application addressed to the FCSIT Dean was received on 16 June 2021 on the unjustified reduction of the time envisioned for the examination by 30 minutes within the study course “Computer Networks” made by the instructor.	In order to resolve the situation, on 17 June, 2021, the FCSIT Dean issued an order canceling the results of the examination and requesting to re-organize the examination following the set procedure.

6.	An e-mail addressed to the Deputy Dean was received on 21 October 2021 on the organization of the tests within the study course “Probability Theory and Mathematical Statistics”	After discussions with the responsible instructor, organizational changes were made to the study course, which allowed resolving the situation.
7.	A complaint addressed to the FETH Dean was received in May 2020 on the used learning materials and the quality of the study courses RTC723 “Introduction to Programming, Design of E-learning Materials and Education Technologies” and RTC700 “Scientific Modelling”	After discussions with the responsible instructors and students, a decision was made to review the curricula of the study courses and move them to Part B1 of the study programme (Decision of the FETH Council of 15 June 2020, Minutes No 70)
8.	Complaints about the quality of the curricula of the study courses, the work of academic staff, and other issues related to the academic activities, which are addressed to the FETH Dean or Vice-Dean for Academic Affairs	All complaints are reviewed and discussed with students, academic staff and the administration of the study program. The decisions made allowed resolving the situations quickly and efficiently. In order to avoid conflict situations, it was decided to organize regular meetings with the students; meetings are organized every 4-6 weeks.
9.	In May 2022, the administrator of the Academic Office of the Institute of Telecommunications received a complaint about the poor communication of the instructor with a student (the instructor did not answer student’s e-mails)	Discussions with the relevant instructor were held. The student was provided with information on the time of the instructor’s tutorials. Student was advised to come in person to meet the instructor and discuss all points of concern.
10.	In February 2022, heads of the study programmes implemented and FET conducted a series of meeting with the course leaders and received complaints on the quality of the curricula of the study courses, work of the academic staff and other issues related to academic activities.	All complaints have been considered and discussed with the responsible instructors of the study courses.

The examples above illustrate the different communication channels that are available to the students, as well as different possible corrective measures used in daily work to ensure the quality of studies.

2.2.4. Provide information on the mechanism for collecting the statistical data, as developed by the higher education institution/ college. Specify the type of data to be collected, the regularity of collection, and the way the information is used to improve the study field. Describe the mechanism for obtaining and providing feedback, including with regard to the work with the students, graduates, and employers.

RTU Quality Policy provides the framework for implementation of the Strategy, the paths for development and improvement of research, study and organization processes. RTU Quality Policy and implementation thereof employ a fact-based approach - decisions are based on the acquired objective data, information analysis and monitoring.

RTU draws up quality reviews based on the analysis of processes and their results. Quality reviews are drawn up once a year, summarizing the data on performance indicators of RTU administration, core activities and support processes.

28 performance indicators characterizing process quality are set for one of the RTU core activity process “Organization and Management of the Study Process”. The data are summarized once a year for the previous academic year by education cycle and study program.

Performance indicators characterize the quality of entrant admission process, study process planning and the quality of implementation of studies - implementation of the initial admission plan, number of matriculated entrants vs. number of entry applications, number of entry applications with RTU as the first priority vs. all matriculated students, number of graduates vs. total number of students, number of exmatriculated students (except for graduates) vs. total number of students, number of students with academic arrears vs. total number of students, number of students exmatriculated due to academic failure vs. total number of exmatriculated students, number of timely signed learning agreements vs. all signed learning agreements, etc.

Observing the current study programme performance, reachable qualitative or quantitative aims are set for the indicators, when possible, e.g., 65 % of the graduates of RTU undergraduate study programmes continue studies at post-graduate study programmes.

The data in the quality review submitted to RTU administration are analyzed by education cycle, by faculty and study field. Indicators of numerous study programmes are compared with the general average RTU level.

The Study Department organizes further review and data forwarding to the faculties and the heads of the study programmes, whereas process managers introduce the necessary improvements. Changes to the approved processes occur in cooperation with quality management specialists.

In addition to performance indicators characterizing study process quality, which are summarized in the review, a study programme quality visualization tool has been created in *Power BI* environment, which will be used to reflect Bachelor and Master study programme performance in an academic year with the help of a radar chart. In the chart, study programme results at each education cycle will be presented comparatively - in relation to the best performance in the respective cycle. The tool is envisioned for the heads of the study programmes and faculty administration to facilitate collection of transparent information on each study programme performance considering numerous indicators simultaneously, as well as to rank the programme in relation to the best performance. It will be also possible to compare the programme performance in several academic years. The tool is currently at the development and test phase. It is planned to summarize 11 performance indicators of the study programmes in the radar chart: academic staff vs. number of students, academic staff with scientific degree, ratio of graduates to the number of matriculated students, number of students who continue studies (not exmatriculated), proportion of foreign students, number of outbound mobility students, Bachelor programme graduates who continue studies at RTU, number of matriculated students from the respective Bachelor study programmes, average assessment of the study programmes in student surveys, number of study materials published on ORTUS e-study system and applicability thereof, as well as financial revenue generated by a study programme per one student. Comparative reviews of the study programme results will be available to heads of all RTU study programmes. It is planned to develop and improve the tool for collection of statistical data necessary for evaluation of the study programme performance and data visualization within the framework of SSO 8.2.3 project.

In addition, RTU Study Department summarizes and annually submits until 15 October to the Central Statistical Bureau and the Ministry of Education and Science a statistical review “Review of the University, College at the Beginning of Academic Year 20_/20_” (Cabinet Regulations No 812 of 20 December 2016, Annex 5 (https://likumi.lv/doc.php?id=287576 (in Latvian)).

The Review contains the following information (sources of information and/or RTU employees responsible for data collection are indicated in parentheses).

- Distribution of students by study programme (Study Management System| Reports | University Review at the Beginning of the Academic Year).
- Enrolment results (University Review at the Beginning of the Academic Year).
- Students having obtained a degree or qualification in the academic year (University Review at the Beginning of the Academic Year).
- Distribution of enrolled students by age (University Review at the Beginning of the Academic Year).
- Distribution of students by age (University Review at the Beginning of the Academic Year).
- Distribution of students having obtained a degree or qualification by age (University Review at the Beginning of the Academic Year).
- University staff in the reporting year as of 1 October (Administrative Office);
- Premise floor area (the Unit of Legal Provision in Real Estate Issues).
- University revenues in the previous year (Planning and Economic Analysis Unit).
- Budget expenditure of the University in the previous year (Planning and Economic Analysis Unit).
- Number of students, who reside in student dormitories (Study Organization Unit).
- Number of students by the language of instruction.
- Distribution of enrolled students by place of residence (University Review at the Beginning of the Academic Year).
- Number of mobility students in the total number of students (University Review at the Beginning of the Academic Year).
- Number of mobility students in the total number of students who have obtained a degree or qualification (University Review at the Beginning of the Academic Year).
- Own revenue from allocation of the mobility student tuition fees by country in the previous year (International Cooperation and Foreign Students Department).
- Revenue from allocation of foreign financial study grants by country in the previous year (Project Financial Management Unit).
- Revenue from allocation of foreign financial study grants for research by country in the previous year (Project Financial Management Unit).

Summarized statistics on the number of students/graduates is used for the following purposes:

- Improvement of the study field. For example, if at some study programme the annual number of student drop-outs is much higher than the number of graduates who obtained degree/qualification, the causes of such a situation are sought for with scrutiny.
- If at some study programme the number of enrolled students decreases annually, the cause should be identified, and potential programme closure should be considered.
- Allocation of financing (for state budget funded seats).
- Compilation of RTU information materials, press, etc.

In order to analyze the study fields and to receive feedback, RTU has developed a polling cycle:

- When starting studies at RTU, a survey of enrolled students is conducted about expectations from studies, availability of information, admission process. The survey is conducted electronically on the ORTUS portal.
- Each semester, the polling of the students at a study programme is conducted to find out student opinion about instructor's work quality and obtain evaluation of the study program. Polling is conducted electronically in ORTUS portal, the results are received by each instructor personally and the head of the organizational unit. The summary of the results is summarized at department meetings, at the meeting of the Study Field Committee and the meeting of the Faculty Council.
- After each graduation round, polling of the graduates of Bachelor and Master programmes is conducted. The results are taken into consideration in the improvement of the study programmes within a study field and discussed at methodological seminars.
- Annual polling of PhD students and PhD alumni has been introduced, it is also planned to conduct surveys of PhD entrants. The polling on the admission procedure and study process has been launched. The summaries of results are published on ORTUS portal. The results are taken into consideration in the improvement of PhD study process and the quality of support provided to PhD students.
- It is also planned to run regular centralized polling of RTU employers. Polling of employers presently takes place at the end of internship of each student, as well as within the scope of development of study programmes.
- From the spring semester of academic year 2020/2021, a mid-semester questionnaire has also been introduced.

Various mechanisms are used to obtain feedback from employers. RTU Advisory Board composed of representatives of different sectors advises RTU Senate and Rector on the RTU Development Strategy. It has the right to propose an issue for consideration at the Senate and the Constitutional Assembly. The RTU Strategy and its development programme are presented in the RTU Advisory Board, the decision-making bodies, as well as to cooperation partners, industry associations and leading companies, with feedback and suggestions being incorporated into the RTU documents.

The involvement of stakeholders and the realization of major projects is the responsibility of the Vice-Rector for Strategic Development, who identifies the existing needs, coordinates the key priorities and activities, implements recommendations and promotes the sustainable development of the RTU.

Employers, as providers of the internship of RTU students, after completing the internship, draw up online feedback on the knowledge and skills of the student, thereby also assessing the relevance of the knowledge provided by the study programme to the needs of the industry.

Employers' feedback is obtained also from the Advisory Board, RTU participation in industry associations, as well as from the assessments provided by employers on the portal prakse.lv (RTU is the most recommended university at https://www.prakse.lv/top for several consecutive years (information available only in Latvian)).

Feedback within study programmes is received through every semester student polling, regulated by the “Regulation on Student Polling for Assessment of the Study Process” (approved by the resolution of RTU Vice-Rector for Academic Affairs No 02000-1.1-e/8 as of 1 February 2021; published at https://www.rtu.lv/writable/public_files/RTU_anketesanas_nolikums.pdf (in Latvian); attached is Annex 20 in the folder List of Internal Regulations).

Abstracts and syllabi of the study courses within the study program, methodological materials, newest educational literature and methodological guidelines for study papers (reports, study papers, internship reports and graduation papers) are reviewed once per academic year.

Courses and seminars on latest teaching methods are organized for academic staff, attendance of the qualification advancement courses is promoted. Academic staff and heads of study programmes participate in different experience exchange activities cooperating with universities from other countries, meeting representatives of respective institutions and entrepreneurs, as well as discussing among themselves latest developments in the sector, research papers and projects of students by analyzing their results.

The Study Filed Committee analyzes recommendations from employers and external experts, which are used as the basis for improvement of the study programmes.

In order to receive feedback from RTU graduates, RTU Alumni Association has been established. It actively operates at the University (http://alumni.rtu.lv/), https://www.facebook.com/RTUAlumni/ (in Latvian)) and runs an online community platform (https://rtuconnect.net/), which aims at developing alumni traditions. In order to ensure the transfer of experience from graduates, RTU Alumni Association provides mentor training, database maintenance, as well as mentor and mentee matching. RTU Alumni Association organizes various events, which bring graduates back to the University, allow for networking, cooperation among the graduates and with the University, and integration in University activities. RTU Grand Graduation Ceremony is a major event introduced by RTU Alumni Association; it gathers the respective year graduates from all nine RTU faculties, academic and general staff, as well as guests.

A summary of the survey data of students, graduates and employers is given in Annex *P18_2.2.4_StudentsGraduatesEmployers_Surveys_ENG*.

2.2.5. Specify the websites (e.g., the homepage) on which the information on the study field and the relevant study programmes is published (in all languages in which the study programmes are implemented) by indicating the persons responsible for the compliance of the information available on the website with the information published in the official registers (State Education Information System (VIIS), E-platform).

Detailed information on the study field and the study programmes pertaining to it with the indication of the languages of instruction is available at RTU web page:

1. RTU web page, in the section on education opportunities in the Latvian language (https://www.rtu.lv/lv/studijas) (responsible person – I. Bušovska, Head of the Admission Department);
2. RTU web page, in the section containing comprehensive information on education

opportunities in the English language (https://www.rtu.lv/en/studies) (responsible person – I. Tipāns, Director of the International Cooperation and Foreign Students Department);

3. Interactive web pages dedicated to RTU study fields, study programmes therein, as well as the detailed description of the offered study courses in the Latvian and English languages (https://stud.rtu.lv/rtu/vaaApp/sprpub and https://stud.rtu.lv/rtu/discpub/list?english=false) (responsible person – G. Alksnis, Head of the Programme Management and Curriculum Design Unit);
4. Web page designed for the foreign student target audience on RTU study programmes implemented in English and student mobility opportunities (https://international.rtu.lv, https://apply.rtu.lv) (responsible person – I. Tipāns, Director of the International Cooperation and Foreign Students Department);
5. E-platform (responsible person – G. Alksnis, Head of the Programme Management and Curriculum Design Unit);
6. State Education Information System (SEIS) (responsible person – I. Pujāts, Project Manager of the Information Technology Department);
7. Web pages of the faculties (are maintained centrally by RTU IT Service in accordance with the information provided by the Study Department, responsible person – G. Alksnis, Head of the Programme Management and Curriculum Design Unit):

- FCSIT: Studiju programmas | Datorzinātnes un informācijas tehnoloģijas fakultāte (rtu.lv)
- FET: Topošajiem studentiem | Elektronikas un telekomunikāciju fakultāte (rtu.lv)
- FETH: https://www.rtu.lv/en/feth/studies-feth/academic-master-study-programme-digital-humanities
- RBS: https://bachelor.rbs.lv/

Each study programme at RTU can create its own individual websites, which allow for more direct communication and informing students about programme topicalities. However, they are seen as more of a daily communication platform. The solution is common to all RTU programmes and is maintained by the staff of the respective program.

2.3. Resources and Provision of the Study Field

2.3.1. Provide information on the system developed by the higher education institution/ college for determining and redistribution of the financial resources required for the implementation of the study field and the relevant study programmes. Provide data on the available funding for the scientific research and/or artistic creation activities, its sources and its use for the development of the study field.

According to the Conceptual Report “Introduction of a New Higher Education Financing Model in Latvia” approved by the Cabinet of Ministers on 29 June 2015 (http://likumi.lv/ta/id/274944-par-jauna-augstakas-izglitibas-finansesanas-modela-ieviesanu-latvija), Latvia has introduced structural reforms in the sector to ensure the development of an efficient and sustainable higher educational system. A three-pillar funding model has been introduced to reconcile the supply offered by higher education with the needs of Latvia’s economic development and labor market, high-quality research-based higher education content and performance management in higher education institutions. The base funding for provision of the study process is the 1st pillar, performance funding is the 2nd pillar, and development funding is the 3rd pillar.

The first pillar, or base (base funding), is implemented through state budget funded study seats. Determination of the number of state budget funded study seats is regulated by Sections 51 and 52 of the Law on Higher Education Institutions (http://likumi.lv/ta/id/37967-augstskolu-likums#p-50515).

RTU funding from the basic state budget is made up of the study base financing corresponding to the list of study programmes and the number of students; it is used to cover such expenses as utilities, taxes, infrastructure maintenance (including data for the Student and Graduate Register), purchase of equipment and supplies, staff remuneration, and funding for research activities.

The number of study seats is allocated after discussions with the Ministry of Education and Science. Funding from the state budget is allocated for full-time studies.

The amount of study base funding is determined on the basis of the number of study seats determined by the state at RTU, as well as the state-defined study seat basic expenses and study cost coefficients in the thematic areas of education.

Study cost coefficients for thematic areas of education are indicators that determine study seat costs in the respective thematic area of education in relation to the basic costs of the study seat.

The cost coefficients for the study programmes in the thematic areas of education for Bachelor and professional study programmes are set by in Annex 1 of Cabinet Regulations of 12 December 2006 “Procedure for Financing Higher Education Institutions and Colleges from the State Budget” (https://likumi.lv/doc.php?id=149900) (further in the text - the Regulations).

Values of study cost coefficients are 1.5 times higher for Master study programmes and three times higher for PhD programmes than the study cost coefficients specified in Annex 1 to the Regulations for the respective thematic area of education.

The amount of the study funding granted to the institution of higher education or college from the state budget for the implementation of Bachelor, professional and Master study programmes is calculated using the following formula:

$$F_s = T_b \times [S(k_i \times n_i) + 1{,}5 \times S(k_i \times m_i)] + S_b \times S(n_i + m_i), \text{ where}$$

F_s – amount of study financing;

T_b – basic costs of the study seat;

k_i – coefficient of the study costs in the relevant field of education (Annex 1 to the Regulations);

n_i – the number of study seats for a higher education institution or college at undergraduate and professional study programmes in the relevant thematic area of education;

m_i the number of study seats at the Master study programmes in the relevant thematic area of education;

S_b – study seat social security expenses at undergraduate, professional and Master study programmes (Annex 2 to the Regulations).

The basic costs of a study seat and the social security expenses of a study seat are determined in accordance with Annex 2 to the Regulations.

Each year, the Ministry of Education and Science calculates the basic costs of a study seat for the following budget year and, by November 1 of the current year, coordinates the calculations with the Ministry of Finance and those Ministries which have higher educational institutions and colleges subordinated to them.

RTU funding from the state basic budget for the provision of study seats in the respective academic year is distributed in accordance with the decision of RTU Senate “Methodology for the Allocation and Use of Funding for the Organizational Units of RTU in Academic Year 2020/2021” (see the file of Annex 16 of the List of Internal Regulations) (hereinafter – the Methodology). The Methodology is reviewed every year and approved in the new edition taking into consideration the necessary changes.

RTU has a decentralized budget, and each organizational unit is allocated a separate budget. In a general sense, a budget is a plan of revenues and expenditures for a specific period of time, work, event or function. The revenues and expenditures of RTU shall be administered in accordance with principles approved by the Senate or as stipulated by the Vice-Rector for Finance endorsed by the Senate.

According to the Methodology, the financing is allocated to the organizational units either according to the financial or budget year or immediately after receiving the financing. The financial or budget year of RTU organizational units is from October to September of the following year, and for this period the financing is calculated and distributed:

- Subsidy or basic budget funding (educating and training of state budget funded students) is divided into monthly limit – 1/12 of the estimated annual funding per month is allocated to the organizational unit;
- Tuition fee funding (educating and training of tuition fee-paying students, including funding paid by students for settling academic arrears) is allocated twice a year (in October and April) as a monthly limit – 1/6 of the estimated funding per semester is allocated to the unit monthly;
- Performance funding (research support funding) is allocated as a monthly limit – 1/12 of the estimated annual funding is allocated to the unit per month;
- Research base funding (research support funding) is allocated as a monthly limit – 1/12 of the estimated annual funding is allocated to the unit per month;
- foreign student tuition fee funding is distributed four times a year, taking into account that the largest amount of the planned workload is allocated to the organizational unit at the beginning of each semester (in October and April), the remaining part of funding - at the end of the semester.

Each head of RTU organizational unit is provided with remote access to operational financial information on the unit’s budget, including the envisaged workload and correspondingly allocated funding for the implementation of study programmes and study courses in subsequent periods. Based on this information, the head of the organizational unit plans the work of the unit at the beginning of each financial or budget year, including remuneration issues for academic staff members who are subordinate to the head of the unit, and develops a procurement plan for the following year in compliance with the implementation and development of the study programme or study course, etc.

According to the World Bank research on higher education governance in Latvia, which was conducted in 2017 and 2018, the World Bank concluded that RTU used the opportunities offered by the system-level funding model reform to gradually adjust the internal distribution of decision-making powers by strengthening the position of the Deans. Prior to the introduction of the second pillar of the state funding model, RTU funding was provided to the units below the level of faculties. To address the issue of weak positions of the Deans, more than half of the new 2nd pillar performance income is used to provide funds to faculties where the Dean is the budget holder. First, it opens up new opportunities for faculty-level strategic development. Second, Deans now have greater opportunities to ensure the development of faculties, which is their responsibility.

Third, since the academic year 2019/2020, Deans of the faculties have additional funding from the tuition fees of foreign students.

Since academic year 2020/2021, RTU has made changes in the Methodology to ensure that the basic state budget funding for the provision of study seats is distributed by study programmes and thematic areas of study courses, ensuring precise distribution of funding according to the indicators by which RTU receives the state budget funding. In addition to the seats financed by the state basic budget, the study programme financing also consists of tuition fee revenue from the resources of natural or legal persons, which can be divided into two subgroups:

1. revenue from local fee-paying students;
2. revenue from foreign fee-paying students.

Funding from local fee-paying students is allocated in compliance with the Methodology where, in order to provide greater opportunities for the development of fee-based study programmes, for several academic years, a significant amount of the funding received has been channeled to the head of the study program, who may appropriately use this funding to renew facilities and attract higher level specialists for the implementation of the study process, etc.

Funding from foreign fee-paying students in a respective academic year is allocated in accordance with the Resolution of RTU Senate On Approval of the "Methodology for Allocation of Funds for Study Process Provision at the International Cooperation and Foreign Students Department" (see the file of Annex 41 of the List of Internal Regulations), further – Methodology2. Methodology2 is revised and approved every year taking into account the necessary changes.

In academic year 2019/2020, RTU made significant changes to Methodology2 with an aim to bring it closer to the Methodology governing budget allocation, thus facilitating the work process of the persons responsible for the implementation of the study programmes – both by aligning funding allocation periods and principles. The new Methodology2 provides funding for the structural unit responsible for implementation of the study programme for its development similarly as in Methodology. Two new coefficients are introduced in the calculation of study course funding - the correction factor for the number of students and the sustainability coefficient of the study program, as well as whether foreign students acquire the study course together with local students. The financial surplus, which is formed from the application of both coefficients and the acquisition of joint study courses, is directed to the organizational unit responsible for implementation of the study program.

Analyzing the financing procedure of the study programmes and the study fields at RTU as a whole, it can be seen that the state basic budget and local fee-paying student funding in the long run are determined taking into account the basic principles established by the state. In the process of determining the amount of funding, the study cost coefficients of the thematic areas of studies and the values of the study cost coefficients according to the level of the study program, as well as the number of students at the study programme and the study courses implemented therein are taken into account. As mentioned above, by using study cost coefficients of the thematic areas of studies, it is possible to determine the amount of financing required for the implementation of a particular study programme and study course. In the Methodology for academic year 2018/2019, RTU Senate approved that in the future the study cost coefficients of the thematic areas of studies would be applied individually to each study course of the study program, thus ensuring even more appropriate amount of financing for the implementation of study courses included in the study programmes. In order to implement this system, the Expert Committee was established by order of the Vice-Rector for Academic Affairs, who determined thematic areas of studies for each study course.

RTU study courses fall in the following thematic areas of studies and have the relevant applicable coefficients:

Thematic area of RTU study courses	**RTU coefficient**
Architecture and urban planning	3.5
Aviation transport	4.2
Construction	2.9
Civil engineering and real estate management	1.71
Civil and occupational safety	2.9
Civil defence	4.2
Computing	2.9
Computer training	2.42
Economics	1.4
Electronics and telecommunications	2.9
Power and electrical engineering	2.9
Physics	3.2
Geodetics and cartography, geomatics	2.9
Innovation	2.9
Engineering drawing	2.9
Quality management	2.9
Chemistry and chemical technology	3.2
Applied arts and design	3.5
Mathematics and statistics	2.42
Materials sciences	3.2
Medical engineering	2.9
Mechanics, mechanical engineering, construction of machines and mechanisms	2.9
Internal security and customs	4.2
Pedagogy	1.67

Heat engineering, heat, gas and water technology	2.9
Social sciences	1.4
Sports	2.0
Textile technology	2.9
Law	1.4
Transport	2.9
Management and administration	1.4
Languages	3.2
History and philosophy	1.4
Environmental engineering and management	3.2
Logistics	1.8

From academic year 2019/2020, similar principles are introduced also in Methodology2 and applied to study programmes, where the total number of foreign students in all academic years is greater than or equal to 90. The study programmes with less than 90 foreign students have a support mechanism, which envisages financing from the total funding of the foreign students, in order to ensure an adequate amount of funding for the implementation of the study courses of the study programmes.

In order to ensure the functioning and sustainable development of study programmes, RTU has been improving the Methodology and Methodology2 for each academic year in accordance with changes in the external and internal environment, thus also eliminating possible risks in the implementation process of the study programme or its study courses. The transition process involves all stakeholders, thus ensuring transparency, as well as a transparent decision-making process. The required changes are at first initiated by RTU Vice-Rector for Finance, and additional changes can be initiated by any RTU employee by submitting a request to RTU Vice-Rector for Finance or to the Finance and Budget Committee of RTU Senate. The Finance and Budget Committee of RTU Senate consists of 20 senators (the figure is variable) - Deans, heads of organizational units of faculties, professors, as well as student representatives who have voting rights, as well as nine RTU Senate advisors, who are mainly representatives of various administrative units, such as Vice-Rectors, heads of departments, etc. Once the Finance and Budget Committee of RTU Senate has considered and evaluated the proposals, it shall propose amendments to the Methodology or Methodology 2 or develop a new version of the document(s) for the next academic year for approval by the RTU Senate comprising 35 senators. It should be noted that historically the changes to the Methodology or Methodology2 have been proposed after performing a thorough analysis, including mitigation of their possible negative impact on the implementation of study programme courses.

Research base funding (base funding provided by the state) is allocated among faculties according to the performance-based output indicators, i.e., number of publications (weighted by impact and citation), funds attracted by research projects and industry contracts, and defended PhD Theses (considering also the time it takes to complete the PhD studies). The calculation is made based on the transparent methodology, which was approved by the Scientific Council (the document: “Methodology for Allocation of Research Base Funding to RTU Organizational Units”) on 20 November 2018. A decision regarding allocation of the budget among faculty institutes is made within faculties (by the Faculty Councils).

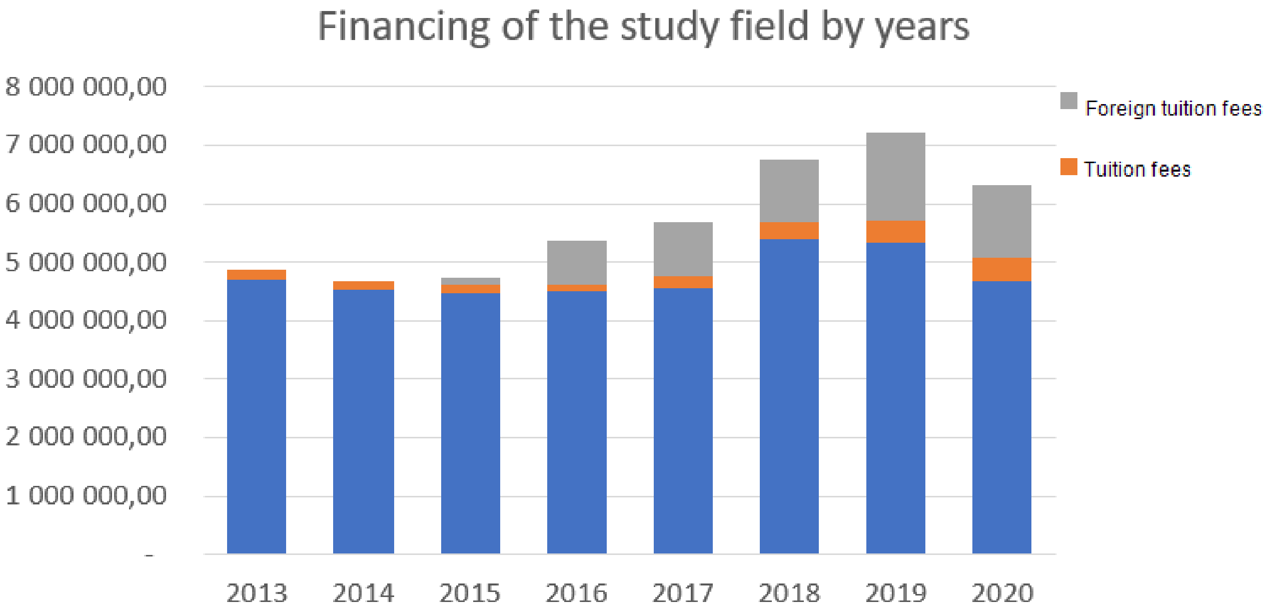
RTU also makes three project calls a year with internal funding. The 1st project call aims at supporting publication activities of young scientists. The 2nd call supports projects where RTU cooperates with industry partners, and this call is aimed at promoting inter-faculty and inter-disciplinary research within six research platforms of RTU. The goal of the 3rd call is to involve graduates in the research process. The regulatory documents are usually approved by the Scientific Council of RTU. However, the decisions regarding selection of particular researchers or projects are made by expert groups organized by the Office of Vice-Rector for Research, at the faculty level or the research platform level (Council of Coordinators of Research Platforms; decision of RTU Senate No. 600 “On Approval of the Regulation of Coordinators’ Board of the Research Platform at Riga Technical University” as of 23 May 2016). Projects are administered by the Office of Vice-Rector for Research. The Office also coordinates administration of the externally funded research projects, e.g., within Horizon 2020 program, etc. Research projects funded by the EU Structural Funds are administered by the Office of Vice-Rector for Strategic Development.

The Internal Research Excellence Grant for young scientists is a new initiative, with an aim to attract talented young researchers to RTU and provide with funding, which allows establishing new research groups in a prospective research field. Funding for a 3-year period is based on international competition under conditions similar to EC ERC grant, and international call and evaluation performed by external, i.e., foreign well-recognized researchers. The final decision for awarding the grant is made by the Scientific Council of RTU.

RTU Research Support Fund (decision of RTU Senate No. 585 “RTU Regulation of Research Support Fund” as of 15 December 2014) aims at providing financial support for various research related activities, such as support for maintenance of research equipment, protection and licensing of intellectual property, covering of expenses related to the PhD study process, publishing of scientific journals, participation and organization of scientific conferences, support to researchers in establishing new laboratories in a prospective research field. The Research Support Fund is an instrument to support research activities, which foster the development of the strategically important research fields. 10 % of the research base funding (state budget funding) is allocated to the Research Support Fund every year. Establishment of seven new laboratories or centers has already been supported by the Fund by June 2020, e.g., RTU High Energy Particle Physics and Accelerator Technology Centre (for cooperation with CERN), Biochip Laboratory, Scientific Laboratory of Experimental Mechanics of Materials, Scientific Laboratory of Electromechatronics, Research Centre of Communication System Technologies, Research Laboratory of Technologies of Electrical Engineering and Ergonomics. The Scientific Council has decided to support on a competitive basis at least one new prospective research direction every year (decision of RTU Scientific Council No. 04000-3/09 dated 21 September 2020).

In academic year 2019/2020, 54 PhD students of RTU received a doctoral research grant. Financial amount for one doctoral grant is 10,000 EUR. Beneficiaries were elected to the position of research assistant or researcher. The aim of RTU doctoral grants is to support research related to the PhD Thesis and to promote the defence of the PhD Thesis in the 4th year after the commencement of the PhD studies.

The financing of the study field in the reporting period is relatively stable, with a tendency to significantly increase the income from tuition fees of the foreign students and local students. Year 2020 was an exception, since it was significantly affected by Covid-19 restrictions, which were the reason why students did not commence or terminated their studies. This is reflected in the decline in the budget revenues as well as in the small amount of foreign tuition fees. In contrast, tuition fees from the local students continued rising.



The total annual income during the reporting period has increased from ~ 4.9 MEUR in 2013 to ~ 7.2 MEUR in 2019, which is the maximum amount of funding for the period or ~ 45% increase against 2013. The total funding to the study field in the reporting period has reached ~ 45 MEUR. The increase in the funding can be attributed to the effective attraction of foreign students, as well as to the stimulating information background created by the industry, actively promoting the field of ICT and computer science in general.

In order to promote the understanding of the organizational units about the budget performance and to promote the systematic development of the faculties, in addition to the information on the budget of each subordinate department, the heads of the departments are provided with a regularly updated report on the general financial results related to the study process demonstrated by the faculties, thus providing transparent performance information not only to the Dean but also to the heads of the institutes, departments and other organizational units.

Publishing the report ensures not only the openness of information but also the possibility for the Dean of the Faculty Council to react promptly in the situations when it is necessary, for example, review of certain expenditure items within the total funding.

Information on the funding available to each study programme in the study field is provided in Section 3.3.3 of this report.

2.3.2. Provide information on the infrastructure and the material and technical provisions required for the implementation of the study field and the relevant study programmes. Specify whether the required provision is available to the higher education institution/ college, available to the students, and the teaching staff.

The construction of RTU Ķīpsala Campus began in 1965 with the aim to create a unified study and research center. The construction process is underway, and it is envisaged to host the majority of university students in Ķīpsala from 2021. After completion of the construction, RTU Ķīpsala Campus will become the most modern engineering study center in the Baltic States.

The issue of sustainable development is taken into account in the construction process of the campus. Recognizing its concern for sustainable development and demonstrating its willingness to engage in the promotion of sustainable development, RTU has joined the Sustainable Development Solutions Network, which seeks to achieve the 17 UN Sustainable Development Goals (SDGs) by 2030. RTU is currently the only organization in the Baltic States that has been admitted to the network.

Through its networking activities, RTU, as a higher education and research institution, has prioritized the achievement of seven UN SDGs that coincide with RTU research platforms. RTU considers the provision of quality education and the promotion of lifelong learning to be its primary goal. RTU also intends to contribute to research and innovation in sustainable and modern water technologies, power systems, infrastructure and urban environment. The University is also committed to promoting the creation and distribution of sustainable products.

RTU buildings are equipped with state-of-the-art climate control equipment, technical solutions that are remotely controlled and provide the opportunity to track energy consumption to make buildings more comfortable for students, academic staff, researchers and guests. One of the results achieved in the development of RTU infrastructure is the participation in the Green Metric Ranking, which recognizes RTU Ķīpsala Campus as the 40th greenest campus in the world and RTU – as the 50th greenest university in the world (https://greenmetric.ui.ac.id/rankings/overall-rankings-2021/rtu.lv). In the Baltic region, RTU is a leader in terms of green thinking infrastructure.

To reduce human impact on the environment and climate change, RTU is committed to introducing the concept of Green Ķīpsala at its campus by 2023. To achieve the goal, RTU is improving its infrastructure in compliance with sustainability principles, changing student and staff habits, and using innovative green products and technologies developed by RTU researchers in Ķīpsala Campus infrastructure.

The infrastructure of Ķīpsala Campus provides students, staff and guests with all the necessary services and utilities, e.g., it is possible to park a bicycle and a car, quench one's thirst at water drinking points free of charge. Developing the infrastructure, care is taken of all groups of people, including people with disabilities: each building has dedicated parking lots, easy access to classrooms, laboratories and other facilities, the use of Braille to provide essential information, as well as all sanitary facilities are designed according to the requirements. The association of people with disabilities and their friends APEIRONS (https://www.apeirons.lv/) commends RTU for its achievements in infrastructure related issues for people with disabilities.

At RTU Ķīpsala Campus, there are currently 54 classrooms, 187 laboratories, 19 special training rooms, 10 computer classrooms, 12 workshops and several research centers of national significance. The Campus also houses a hostel with 950 beds and a special area for people with disabilities to ensure a favorable and comfortable living.

Foreign students, visiting academic staff and university guests can use the renovated RTU student dormitories (22a Āzenes Street, Riga).

Other elements of RTU infrastructure are also available for the needs of students and academic staff - canteens and cafes located in each of the RTU complexes, photocopiers, hostels, RTU sports and recreation centers, swimming pool, etc. RTU premises are equipped with drink and snack vending machines.

Wi-Fi is provided in all classrooms of the Campus which allows students to access study materials placed on the RTU study portal ORTUS.

The following units participate in the implementation of the study programmes within the study field using their own material and technical resource base and infrastructure: *Faculty of Computer Science and Information Technology (FCSIT), Faculty of Electronics and Telecommunications (FET) and Faculty of E-Learning Technologies and Humanities (FETH), and Riga Business School (RBS)*. The buildings of FCSIT and FET are located in Ķīpsala Campus, which houses the library, sports complex and other elements of infrastructure described above. FETH is located in Riga, 1 Kronvalda Boulevard, in the same building with RTU Engineering High School. RBS is located in Riga, 11 Skolas Street in the landscaped territory with asphalted access roads, paved sidewalks, well-groomed lawn, and benches. Faculty buildings provide access for the people with special needs. There are WC facilities on each floor and a specialized water fountain. There is a lift, an open-plan wardrobe and a reading room, several lounges, student study rooms, auditoriums and rooms for academic personnel, meeting rooms and a café.

The infrastructure and material resources available at the faculties are variable. The infrastructure and material and technical resource base at the disposal of each faculty as of March 2022 are described below.

Faculty of Computer Science and Information Technology (FCSIT)

The new FCSIT building together with RTU Auditorium (Domus Auditorialis) located at 10 Zunda Embankment was put into operation in December 2021. These are the newest buildings in Kipsala Campus. The FCSIT building received the 2nd place in the 2021 competition in the category New Public Building. This attests the high quality of the building and the suitability of the floor planning for public use. FCSIT together with FET, RTU Auditorium (Domus Auditorialis) and FEEE (Faculty of Electrical and Environmental Engineering) are located in a single study and science building complex with common auditoriums.

In compliance with their needs, students, researchers, academic and administrative staff, and guests have adequately equipped premises at their disposal (see table):

Intended use of rooms	**Number**	**Useful area (m²)**
Lecture hall	10	899.02
Laboratory	3	152.65
Computer room	16	1395.57
Classrooms	66	1629.16
Academic staff premises - tutorial room	48	1268.86
National Research Center (NRC)	7	447.88

Student self-government and record management	2	105.06
Meeting room	1	62.27
Server room	6	74.63
Computer maintenance room	1	32.79
Kitchen	6	151.75
WC, shower for the people with disabilities	13	194.34
Auxiliary room, maintenance room	16	55.08

Faculty of Electronics and Telecommunications (FET)

Faculty of Electronics and Telecommunications (FET) is located in Riga, at 12 Āzenes Street. There is a developed infrastructure in the vicinity of the FET building, with convenient public transport connection, cafes, supermarket, and the sports center.

The total useful area of the FET building is 4729.80 m^2, there are four floors, there are WC facilities on each floor. The faculty building has access for people with special needs. Bicycle and car parking is available. The building has a specialized a drinking water fountain, an elevator, a student room, classrooms and academic staff rooms, various laboratories, a café, as well as vending machines for various drinks and snacks.

Compliance of the premises and technical equipment with the quality requirements is constantly monitored in the FET building at 12 Āzenes Street. Appropriate auditoriums with the necessary multimedia equipment have been set up (see table):

Intended use of rooms	**Number**	**Useful area (m^2)**
Dean’s Office	4	90.30
PhD student room	2	60.40
Office	2	36.50
Kitchen	3	35.10
Conference hall	1	30.60

Laboratory facility	27	1351.10
Classroom/Seminar hall	2	109.90
Academic staff premises	22	409.30
Computer room	2	93.70
Student self-government	1	31.60
Workshop	1	23.00
Student support room	1	30.50

Faculty of E-Learning Technologies and Humanities (FETH)

Compliance of the premises and technical equipment with the quality requirements is constantly monitored in the FETH busing at 1 Kronvalda Boulevard. Appropriate auditoriums with the necessary multimedia equipment have been set up (see table):

Intended use of rooms	**Number**	**Useful area (m²)**
Auditoriums	3	263.4
Computer lab	3	162.0
Dean's Office	1	65.2
Office	6	116.9
Academic staff premises - tutorial room	2	68.9
Resource room	1	71.1
Student self-government premise	1	45.4
Meeting hall	1	19.8

Information on the material and technical resource base available to each study programme in the study field is provided in Section 3.3.1 of this report.

2.3.3. Provide information on the system and procedures for the improvement and purchase of the methodological and informative provision. Description and assessment of the availability of the library and the databases to the students (including in digital environment) and their compliance with the needs of the study field by specifying whether the opening times of the library are appropriate for the students, as well as the number/ area of the premises, their suitability for individual studies and research work, the services provided by the library, the available literature for the implementation of the study field, the databases available for the students in the respective field, the statistical data on their use, the procedures for the replenishment of the library stock, as well as the

procedures and possibilities for the subscription to the databases.

Library plays an important role in the provision of methodological guides and educational resources to students. RTU Scientific Library (SL) (https://www.rtu.lv/en/studies/scientific-library) is a library of national importance, which has acquired its status in the process of library accreditation. The SL provides the necessary information to ensure RTU study process and research activities, as well as provides library, bibliographic and information services to RTU students, academic and general staff. The Library stocks more 1.29 million printed documents and e-resources in RTU industry specific databases. The Library stock is located at the Central Library, the Study Material Subscription, the Chemistry Branch, the Transport Branch and Study and Research Centers in Daugavpils, Liepāja, Cēsis and Ventspils.

In 2016, significant investments were made in the development of the SL infrastructure by building additional premises (2240 m^2). The total area of the SL premises is 6393 m^2, of which 3417 m^2 are reader service premises. There are 713 working places for SL users. The SL has four group rooms and six individual booths, a rare book reading room and a conference room. The SL is accessible for users with disabilities.

In order to improve the Scientific Library activities and to meet the information needs of academic and research staff, the Library Council has been established, which decides on replenishing the library collection with printed publications and subscribing to the necessary databases. The Library Council has approved the Compilation Policy of RTU Scientific Library Collection, which sets the basic principles of the collection development in accordance with the areas of RTU academic and research activities.

After the Scientific Library receives its funding from RTU, it calculates funding for the information resources for each study program. The collection is replenished taking into account the recommendations of the head of a respective study programme and researchers, in compliance with the allocated funding. By contacting the Scientific Library Collection Development Department regarding replenishment of collection, the desired editions can be ordered at the Library website by filling out an order form, an application form (https://www.rtu.lv/lv/studijas/biblioteka/pakalpojumi-3), contacting by phone 67089353, or visiting the Library at 5-105 Paula Valdena Street. The Scientific Library offers a guide, which includes websites of various Latvian and foreign publishing houses and bookstores for searching publications and e-resources.

Database subscription agreements are concluded both directly with the supplier and through the state agency Cultural Information Systems Centre, which is the Latvian national representative for the international non-profit organization Electronic Information for Libraries (EIFL) (https://www.eifl.net/). The EIFL Licensing Programme offers libraries of state importance to subscribe to internationally recognized databases at a significantly reduced subscription fee that is not offered to individual subscribers, thus saving the financial resources of libraries.

In total, in the period from 2013 to 2021, SL has purchased 902 new book titles for the amount of EUR 61105.90 for the needs of the RTU study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”.

- 81 new book titles for the amount of EUR 5523.76 were been purchased upon request of the study programme “Smart computer technologies” (previously “Automation and Computer Engineering”) in the period from 2013 to 2021.
- 295 book new titles for the amount of EUR 16024.64 were purchased upon request of the

study programme “Computer Systems” in the period from 2013 to 2021.
- 140 book new titles for the amount of EUR 9141.82 were purchased upon request of the study programmes “Information Technology” in the period from 2013 to 2021.
- 82 new book titles for the amount of EUR 4163.14 were purchased upon request of the study programmes “Business Informatics” in the period from 2013 to 2021.
- 34 new book titles for the amount of EUR 2638.85 were purchased upon order of the study programme “Logistics Systems and Supply Chain Management” in the period from 2016 to 2021.
- 26 new book titles for the amount of EUR 2317.36 were purchased upon request of the study programme “Intellectual Robotic Systems” in the period from 2015 to 2021.
- 9 new book titles for the amount of EUR 676.82 were purchased upon request of the study programme “Financial Management Information System” in the period from 2019 to 2021.
- 7 new book titles for the amount of EUR 527.93 were purchased upon request of the study programme “Cybersecurity” in the period from 2020 to 2021.
- 113 new book titles for the amount of EUR 9683.83 were purchased upon request of the study programme “Telecommunications” in the period from 2013 to 2021.
- 45 new book titles for the amount of EUR 4341.76 were purchased upon request of the study programmes “Electronics” in the period from 2013 to 2021.
- new book titles for the amount of EUR 496.48 were purchased upon request of the study programme “Smart Electronic Systems” in 2021.
- 20 new book titles for the amount of EUR 1887.38 were purchased upon request of the study programme “Electronics and Mobile Communications” in the period from 2016 to 2021.
- 46 new book titles for the amount of EUR 3682.13 were purchased upon request of the study programme “Transport Electronics and Telematics” in the period from 2013 to 2021.
- 35 new book titles for the amount of approximately 3500 EUR were purchased upon request of the study programme “Digital Humanities” in the period from 2017 to 2021.

Every month, the list of the newly-received literature is published in the Scientific Library newly-received literature bulletin (https://www.rtu.lv/lv/studijas/biblioteka/jaunieguvumi)(only in Latvian)

The List of Database Subscribed by the Scientific Library

(https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/abonetas-datubazes)(only in Latvian):

- ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, eBook Academic Collection EBSCOhost, MasterFILE Reference eBook Collection EBSCOhost, MasterFile Premier EBSCOhost, eBook Open Access Collection EBSCOhost, Open Dissertations EBSCOhost.
- Databases funded by the Ministry of Education and Science: ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate).
- Latvian databases: LETA, Letonika, Latvian Standards Database (available on Library premises).

The e-resources that are most appropriate for the needs of the study programmes in the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” are as follows:

- **E-book databases:** SpringerLink, Proquest Central Academic Complete, eBook Academic Collection EBSCOhost, eBook Open Access Collection EBSCOhost, ScienceDirect handbooks

(Elsevier).
- **E-journal databases:** IEEE Xplore Digital Library, ACM Digital Library, Applied Science & Technology Source EBSCOhost, ScienceDirect Freedom Collection (Elsevier), Academic Search Complete EBSCOhost, Wiley Online Library, MasterFile Premier EBSCOhost.

Database use at RTU Scientific Library has been growing since 2016. For instance, in 2021, lending of digital resources achieved 418,103.

New premises of the library allow offering an extended range of services for the users. Since the opening of the new premises the number of the library visitors has grown from 103825 to 691200. The central library of the Scientific Library is open for users Monday through Saturday (https://www.rtu.lv/lv/studijas/biblioteka/darba-laiki-un-kontakti). The 24-hour reading room is available. Upon student request, during the examination session in December 2019 and January 2020, five floors of the Central Library with stock were available for the users 24 hours a day. During the summer, the Central Library is open every weekday with reduced opening hours.

The library sources are housed in an open-access collection. Books and periodicals relevant for the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” are available in the open access in the central building of the Scientific Library, 5 Paula Valdena Street, Riga. The books are located according to their UDC indexes.

UDC indexes relevant for the study field:

004 Computer science and technology. Computing. Data processing

004.4 Software

004.43 Computer languages

004.45 Systems software

004.6 Data

004.7 Computer communication. Computer tools

004.8 Artificial intelligence

004.9 Application-oriented computer-based techniques

004.92 Computer graphics

621.37 Electric wave, electromagnetic wave, oscillation, vibration technology

621.38 Electronic devices. Electron lamps. Photocells. Accelerators

621.39 Telecommunications. Telegraphy. Telephony. Radio communication. Video technology and equipment. Remote control

621.391 General issues of communications engineering. Cybernetics. Information theory. Signal theory

621.395 Telephony technologies and equipment

621.396 Radiocommunication apparatuses and methods (radio)

656 Transport and postal services. Traffic organization and control

656.25 Security tools. Signals

681.513 Control systems with a defined input

The last copies of the oldest publications corresponding to the RTU profile are kept in the library repository. They are always available to the users.

The librarian on duty helps visitors find their way around the collection. Bibliographers (information specialists) provide more detailed information and advice. The library has a branch librarian service. (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija) (only in Latvian).

The library resource search is supported by the *Primo Discovery* search tool (https://www.rtu.lv/lv/studijas/biblioteka/vienota-informacijas-meklesana)(only in Latvian). It allows searching the library catalogue, the subscribed databases , as well as the databases created by the RTU Scientific Library in one interface.

Searching for information in the electronic joint catalogue (https://kopkatalogs.lv/F)(only in Latvian), it is possible to simultaneously obtain information on the resources available in 13 Latvian libraries.

The manual "How to search for resources in the catalogue" has been drawn (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/ka-meklet-kataloga)(only in Latvian).

Both the electronic catalogue and the RTU portal ORTUS allow remote reservation of library resources, as well as remote access to the databases. Since the introduction of RFID technology, users can use five self-service book-dispensing machines and check out books from the pick-up machines around the clock. Use term of the books can be extended remotely.

The SL provides students, academic personnel and other stakeholders with various levels of individual consultations and group training in information literacy (https://www.rtu.lv/lv/studijas/biblioteka/lietotaju-apmacibas)(only in Latvian).

Publications not available in the SL are delivered via an interlibrary loan or an international loan. Internet access is available throughout the library. The library has copying, scanning, printing, binding services and a self-service dining room.

It is possible to contact the Library vis the following channels: Ask Librarian (https://www.rtu.lv/lv/studijas/biblioteka/jauta-bibliotekaram)(only in Latvian) using the informative email or calling to the informative phone (https://www.rtu.lv/lv/studijas/biblioteka/darba-laiki-un-kontakti)(only in Latvian).

Section 3.3.1 of the description of each study programme in the study field contains information on the program-specific information provision. For PhD study programmes, detailed information on the resources of the academic and research base is given in Section 3.3.2 of the description of the PhD program.

2.3.4. Provide a description and assessment of information and communication technology solutions used in the study process (e.g., MOODLE). If the study programmes within the study field are implemented in distance learning, the tools specially adapted for this form of study must also be indicated.

Owing to a high level of digitalization, the available infrastructure and material and technical facilities for the implementation of the study field and corresponding study programmes provide an opportunity to increase the University's competitiveness, improve operational quality and efficiency, as well as to make information available by integrating IT solutions into administrative, academic and research processes of the University and providing administrative and academic staff with modern, reliable, secure and unified IT infrastructure and quality IT services.

The IT Department works in three areas:

1. design, development and maintenance of an integrated RTU information system providing support for RTU administrative, academic and research work;
2. provision of high-quality and continuous voice and data transmission services in the entire territory managed by RTU, as well as maintenance of RTU data centers and main network resources;
3. support in the use of IT services, including informing the users about new IT solutions, providing the necessary consultations and organizing IT training.

To ensure easy and efficient identification of IT users, an IT user identity management system has been introduced; as a result, each IT user has a unique electronic identity that is valid in all information systems. In addition to the aforementioned, a user session management system is ensured in IT systems, which means that there is no need for IT users to re-authenticate when logging in to RTU information systems. It gives the experience of using a unified integrated information system without having to memorize different identification data and re-enter them, implementing different IT application scenarios.

All IT users are provided access to the centralized portal ORTUS (https://ortus.rtu.lv – screenshot of the interface are attached in the Annex “Screenshots of RTU IT systems”), which functions as a single digital gateway, combining information from all RTU information system components and providing users with an easy-to-use way of accessing the directory of all IT services in one place.

The Centralized Study Management System is used for efficient administration of the study process, which ensures digital provision of the study life cycle, incl. Electronic Register of the Study Programmes (its public part is available at https://stud.rtu.lv/rtu/vaaApp/sprpub – screenshots of the interface are attached in the Annex “Screenshots of RTU IT systems”), drawing up learning agreements and enrolment of students in study programmes, Register of the Study Courses (its public part is available at https://stud.rtu.lv/rtu/discpub/list – screenshots of the interface are attached in the Annex “Screenshots of RTU IT systems”), designing student’s individual study plans, drawing up orders, implementing study courses and study process, registering grades, recognizing study courses, awarding qualifications, administering payments, student dormitory information, gathering information to issue diploma supplements, etc. This system is one of the main cornerstones in the administration of RTU study process.

To ensure effective implementation of the study process, *Moodle* e-learning system is used, where all relevant information is compiled in an automated way (study courses, users, groups, access rights, etc.). This system ensures student-instructor communication.

The academic staff members place various electronic materials, assessment tests, homework assignments, information on a particular study course, etc. in the system. Students can also view their financial information on the ORTUS portal, as well as make request for documents (references, transcripts of records, copies of a learning agreement, etc.). For distance learning, RTU academic staff has options to use *Zoom* or *Microsoft Teams* videoconferencing platforms.

Since 2007, more than 130,000 unique study course sites have been generated in the e-learning environment of RTU. Students can access electronic learning resources anytime and anywhere.

Digitalization of classrooms and schedules has been carried out to ensure efficient premise management and study planning (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/ – screenshots of the interface are attached in the Annex “Screenshots of RTU IT systems”). Each RTU student and academic staff member can access their schedule, which provides information on the venue, time, instructor, room, title and type of lecture. In addition, for user's convenience purposes, the system greatly facilitates lecture planning and scheduling, as well as optimizes efficiency of premise occupancy and use.

Electronic Staff Management and Record-keeping Systems, which cover the circulation of record-keeping and personnel documents at RTU (https://docs.rtu.lv/ – screenshots of the interface are attached in the Annex "Screenshots of RTU IT systems"), are also used to ensure the efficient administrative work. Electronic document coordination and document e-signing functionality have been introduced, thus reducing print-based document circulation and significantly increasing document circulation speed. Since autumn semester of 2019, students have been provided with electronically signed learning agreements. Since 2016, RTU graduates have been receiving electronically signed transcripts of records.

In terms of quality assurance, a digital student survey system is used, with the help of which the quality control of study courses and study programmes is implemented each semester. Based on the results of quality control, regular measures are taken to improve study programmes and the study process, in general.

For additional convenience of RTU students, academic and general staff members, RTU leases *Microsoft Windows* and *Microsoft Office* software, which provides all IT users with access to the latest *Microsoft* software. RTU students can use the licensed *Windows* operating system and the *Microsoft Office* productivity suite provided by RTU for their academic needs. All IT users have access to *Microsoft Office 365* cloud computing platform with one terabyte of storage space available to each user and access to a variety of additional collaboration and productivity tools (*Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook*, etc.). RTU students, academic and general staff have access to the University's email system.

To support research activities, RTU has developed the Centralized Research Support System, which records all information on publications, patents, commercialization applications, Doctoral Theses, RTU scientific journals, research staff, etc. The system provides access to information according to *Open Access* principle (https://science.rtu.lv – screenshots of the interface are attached in the Annex "Screenshots of RTU IT systems"). RTU students and academic staff also have centralized access to research software.

RTU has the high-speed fiber optic Internet and extensive wireless network infrastructure with over 400 access points, including the international *Eduroam* service. In addition, desk phones and mobile communications are provided for fast and easy communication.

To ensure a stable and secure operation of the IT infrastructure, continuous monitoring of the IT infrastructure and systems is performed, resulting in proactive incident control. Data backup is also ensured.

The Information Systems Security Policy has been developed and implemented with the primary goal of ensuring the secure use of RTU information systems by establishing and maintaining a sufficient set of measures to reduce or prevent potential or resulting harm. Implementation of the Information Systems Security Policy envisages security checks, data transmission network monitoring, as well as preventive measures. Regular IT security and personal data protection training is organized for IT users. Automated security incident management and risk management have been implemented. Statistics demonstrate that the number of IT security incidents dropped significantly over the last five years.

The IT User Support Centre provides IT user support, by applying a one-stop approach to process applications based on ITIL guidelines. Since 2007, the IT User Support Centre has processed and resolved more than 160,000 IT user applications.

The types and number of technical equipment vary. The information on specific technical equipment at each faculty as of March 2022 is given below.

Faculty of Computer Science and Information Technology (FCSIT)

FCSIT has the following multimedia equipment at its disposal (the table also includes auditorium equipment):

Equipment	**Quantity**
Portable and tablet computers	183
Desktop computers	544
Monitors	547
Copiers, including scanners	19
Projectors	58
Printer	53
Portable data terminal with label print printer	2
Television sets	5
Interactive displays	3
Document camera	1
Videoconferencing equipment	1
Graphic tablet	1
Desktop mirroring displays	5

The resources at the disposal of the RTU Computing Centre in order to qualitatively ensure the education process and research activities include:

- L2, L3 level networking equipment up to 10 gigabits/s is involved in the provision process. The equipment is connected to other university infrastructure equipment ensuring stable, uninterrupted speed. For the purpose of obtaining scientific research data, computer classes are equipped with optical cable network equipment that supports its.
- The provision process involves physical servers on which virtual servers are operated using Hyper-V technology. To ensure high availability and security of the servers, Microsoft Hyper-V Failover Cluster technology is used, which allows increasing computing power, load balancing and availability (5 servers with at least 120GB RAM). In addition to Microsoft Hyper-V server virtualization technologies, VmWare vSphere Essentials virtualization solution is used for maintaining faculty infrastructure and learning information systems (2 servers with 288GB RAM), as well as CloudStack cloud computing solution for scientists (16 blade-type servers with at least 2TB RAM).

- In two computer classes, computers are equipped with high-performance graphics (GPU) cards and 10 gigabit network cards, which are connected in a single network with Mikrotik equipment (switch).
- Interactive auditorium equipment is available in computer classes to improve the quality of the learning process. For the needs of the learning process, computer classes are provided with the licensed software, such as ADONIS, Aimsun Next, Anaconda3, AnyLogic, Arena, Blender, GIMP, GIT, Inkscape, LibreOffice, MATLAB, MS Office, MS SQL Server, MS Visual Studio, MySQL (package), OlapCube, Oracle VM VirtualBox, PuTTy, QGIS, R, R, RStudio, WireShark.

Faculty of Electronics and Telecommunications (FET)

FET continuously monitors the compliance of the quality requirements of premises and technical equipment, if necessary, by repairing worn-out equipment or replacing parts, so that the study process is not disturbed. All premises intended for the learning process are equipped with modern multimedia equipment – a computer with a connection to the Internet, a speaker system, a projector that allows ensuring the education process that meets the modern requirements.

Equipment	Quantity
Portable and tablet computers	88
Desktop computers	186
Monitors	196
Copiers, including scanners	6
Projectors	13
Printer	31
Television sets	2

E Faculty of E-Learning Technologies and Humanities (FETH)

FETH has the following multimedia equipment at its disposal (the table also includes auditorium equipment):

Equipment	Quantity
Portable and tablet computers	5
Desktop computers	60
Monitors	60
Copiers, including scanners	4
Projectors	6
Printers	6

Television sets	1

The premises of the Faculty of E-learning Technologies and Humanities at 1 Kronvalda Boulevard are equipped with everything necessary to comprehensively implement the study process that meets the requirements of the modern higher education. Each study auditorium has a set of multimedia equipment installed – a computer with the internet connection, a speaker system, a projector. The auditorium equipment, office equipment, computer equipment, software for the learning process are periodically improved. Students of the study programme have been provided with workplaces in computer laboratories with computer software necessary for the acquisition of the study program. The issue of purchasing and updating new and existing software is considered and reviewed annually.

Section 3.3.1 of the description of each study programme in the study field contains information on the software and hardware-specific provision specific to the study program. It is important to note that the technical equipment and facilities available for the study field may be used in the implementation of all study programmes therein.

2.3.5. Provide information on the procedures for attracting and/or employing the teaching staff (including the call for vacancies, employment, election procedure, etc.), and the assessment of their transparency.

The implementation of RTU personnel policy is stipulated in the Human Resources Development Plan, which focuses on three main goals within the professional development of the academic staff: renewal of the academic staff, by promoting academic work of PhD students, improvement of the professional competence of the existing academic staff and attraction of foreign academic staff. The action plan sets out, for each goal, the activities and sub-activities to be carried out, defines the results to be achieved, the responsible organizational units and the implementation schedule.

Elections of RTU academic staff are held in accordance with the requirements of the Law on Higher Education Institutions and Cabinet regulations based on the recommendations of the Council of Higher Education, in accordance with the Constitution of RTU and the regulations approved by the Senate “On the Procedure of Electing Professors and Associate Professors” and “On the Procedure Of Electing Assistant Professors, Lecturers and Assistants” (publicly available at https://www.rtu.lv/lv/universitate/vakances-rtu/personalatlases-dokumenti (only in Latvian), as well as included in the file of Annex 42-43 of the list of Internal regulations), as well as in compliance with other internal laws and regulations.

At the proposal of organizational units, the faculty council or the institute board shall consider and approve a reasoned proposal made by the head of a respective organizational unit for announcement of the competition for vacant academic positions, which expire in the respective academic year. The faculty council or the institute board shall submit the proposal under consideration to the RTU Personnel Department together with the job description and qualification requirements, including the workload (full-time or part-time).

Regarding academic positions for professors and associate professors, where the term of election expires in the respective academic year, periodic evaluation of scientific and pedagogical qualifications is performed in accordance with the Procedure for Election of a Candidate for the Position of Professor or Associate Professor and the Procedure for Assessing the Qualification of an Existing Professor or Associate Professor approved by the RTU Senate Meeting on 29 June 2020 (published at https://www.rtu.lv/writable/public_files/RTU_par_profesoru_un_asocieto_profesoru_periodisko_novertesanu_apstiprinasanu.pdf) (only in Latvian).

The Personnel Department informs the head of the organizational unit of the professor or associate professor about the need to organize the evaluation of the professor or associate professor. The evaluation is performed by the Board of Professors of the field in accordance with the Law on Higher Education Institutions, the Regulations of the Council of RTU Professors and the Regulations on Periodic Evaluation of Professors and Associate Professors approved by the RTU Senate. After the evaluation, the Council of Professors of the study field submits an opinion on the result of the evaluation to the Rector and the Personnel Department. Taking into account the evaluation of the Board and the procedures and criteria set by the higher education institution, the employment contract with the associate professor or professor may be extended for a definite or indefinite term. If, as a result of the evaluation, the scientific and pedagogical qualification of a professor or associate professor meets the evaluation criteria set by the higher education institution, the employment relationship is continued. If, as a result of the evaluation, the qualification of a professor or associate professor does not meet the evaluation criteria set by the higher education institution:

- the relevant employment contract of the professor or associate professor is terminated;
- the department may decide to announce a new vacancy.

The Personnel Department announces a competition for academic staff positions at RTU website, the *Euraxess* vacancy portal and at least in one mass medium distributed throughout Latvia. The applicant shall personally submit or send by email the signed application documents no later than one month after the date of competition announcement.

The employment relationship shall be established by means of a written employment agreement between the Employer and the Employee at least two working days before the commencement of employment. The employment agreement shall be drawn up in duplicate. One copy shall be kept by the Personnel Department (in accordance with RTU File Nomenclature) and the other shall be issued to the Employee. Prior to entering into the employment agreement, the applicant is acquainted with RTU Rules of Procedure.

Employee's duties are defined in accordance with the Classification of Occupations of the Republic of Latvia and RTU Position Catalogue, Unified Work Remuneration Procedure at RTU (https://www.rtu.lv/lv/universitate/skaitli-un-fakti/vienota-darba-samaksas-kartiba (only in Latvian), see also the file of Annex 44 of the list of Internal Regulations), RTU Rules of Procedure and the requirements laid down in the job description, which is an integral part of the employment agreement. Job description shall be presented to and signed by the Employee. Job description shall be drawn up in duplicate; one copy shall be issued to the Employee and the other shall be kept according to RTU Case Nomenclature.

Before taking up the employment, the applicant shall present an identity document – passport or identity card, the foreigner shall additionally present a visa or residence permit, as well as a work permit if such a permit is required in accordance with regulatory enactments.

Visiting academic staff shall be employed in compliance with:

- Law on Higher Education Institutions (https://likumi.lv/doc.php?id=37967);
- Labour Law (https://likumi.lv/ta/id/26019-darba-likums);
- Immigration Law (https://likumi.lv/ta/id/68522-imigracijas-likums);
- Cabinet Regulations No 568 "Regulations Regarding the Procedure by which a Research Institution Concludes and Terminates Employment Agreements with a Foreign Researcher" as

of 21 July 2008 (https://likumi.lv/doc.php?id=178749) (only in Latvian);

- Cabinet Regulations No 225 “Regulations Regarding the Amount of Financial Means Necessary for a Foreigner and the Determination of the Existence of Financial Means” as of 25 April 2017 (https://likumi.lv/doc.php?id=290808)(only in Latvian);
- Cabinet Regulations No. 25 “Implementing Regulations for the First, Second and Third Project Applications Selection Round of Specific Objective 8.2.2 “To Strengthen Academic Staff of Higher Education Institutions in the Areas of Strategic Specialization” of the Operational Programme “Growth and Employment”” as of 9 January 2018 (https://likumi.lv/doc.php?id=296513)(only in Latvian);
- RTU internal regulations “Procedure of Involvement and Employment of Visiting Academic Personnel at RTU” as of 26 November 2018 (see the file of Annex 25 of the list of Internal regulations);
- RTU internal regulations “Unified Work Remuneration Procedure at Riga Technical University” as of 27 April 2020 (amendments on 28 September 2020, 21 December 2020, 25 January 2021) (see the file of Annex 44 of the list of Internal regulations).

According to the results of the applicant selection competition, the employment agreement with the visiting academic staff is signed within a month, specifying an hourly rate. Job description is also provided, which includes specific job responsibilities (delivering lectures, designing study courses, lecture cycles, supervising study papers, etc.). The workload of the visiting academic staff member may include the provision of face-to-face work (delivering lectures, providing tutorials, conducting seminars, supervising graduation papers, etc.) and remote work if it complements the face-to-face work (video lectures, tutorials, supervision of graduation papers). If the work is to be carried out remotely, face-to-face visits (e.g., tutorials) should be provided at the organizational unit.

The visiting academic staff member shall enter into the employment agreement in compliance with the requirements of the Latvian regulatory enactments. During the term of the employment agreement, all assignable copyrights for the work created by the visiting academic staff member, including curricula, materials, and any other teaching aids developed by the visiting academic staff member, shall pass to the Employer. The visiting academic staff member, upon termination of the employment agreement, shall be obliged to transfer the work created within the framework of the employment agreement, including study materials, to RTU. Before terminating the employment agreement, the visiting academic staff member shall submit to the head of a respective organizational unit the reports and other documents stipulated in the employment agreement.

2.3.6. Specify whether there are common procedures for ensuring the qualification of the academic staff members and the work quality in place and provide the respective assessment thereof. Specify the options for all teaching staff members to improve their qualifications (including the information on the involvement of the teaching staff in different activities, the incentives for their involvement, etc.). Provide the respective examples and specify the way the added value of the possibilities used for the implementation of the study process and the improvement of the study quality is evaluated.

At the end of 2018, the Centre for Academic Excellence (teaching and learning centre) was established at RTU in order to support RTU academic staff (in the areas of pedagogical, intercultural communication and self-development). The main tasks of the Centre for Academic Excellence are as follows:

- to organize various educational events, such as seminars, thematic series of events, guest lectures, conferences, discussions with the participation of the Latvian and foreign specialists;
- to coordinate experience exchange activities within faculties and other organizational units;
- to inform (including posting to ORTUS) the academic staff about the latest teaching and learning trends that are appropriate for RTU;
- to provide guidance to academic staff on the use of teaching and learning methods, as well as on the assessment of students' knowledge, skills and competence;
- to inform students about learning opportunities, such as platforms, systems, applications, effective methods and forms of learning that can be used both in the study process and individually.

Each semester, a core set of activities is offered taking into account the professional competence and needs of the academic staff, which are identified through a survey, in which the lecturers indicate the most important topics and areas in which they want to improve themselves. Student surveys data and information from student self-governments are also evaluated, to gain some topics which should be improved for lecturers from students' point of view. At the same time, proactive actions are being taken to assess the potential needs of academic staff.

The Centre for Academic Excellence organizes two methodological conferences a year. The conference organized in the autumn semester is dedicated to the modern content of the study courses, while the conference held in spring focuses on modern teaching and learning methods. Materials of all events are available on ORTUS Moodle system within the study course "Materials of the Centre for Academic Excellence".

After each professional development event, participants complete assessment questionnaires, which enable organizers to improve the range of offered events. In order to promote the development of competences of the academic staff, the student surveys are analyzed each semester, as well as discussions with the representatives of faculties, student self-governments and the instructors themselves take place.

Academic personnel have the opportunity to improve their English language skills by applying to the courses offered by the RTU Institute of Applied Linguistics or by the RTU Riga Business School, which are organized thanks to SOO 8.2.2 project funding.

Along with the announcement of the emergency situation and transfer of the education process to the remote mode, the CAE on the ORTUS portal developed a site "Support in the provision of remote courses". The site consists of six sections: General Information, Technical Assistance, Pedagogical Assistance, Experience Stories, Distance Exams and Mutual Support. Each section is regularly updated with relevant resources. Academic staff appreciate such the resource, and also suggest the other materials to be included.

Since March 2020, almost 80 webinars have taken place (both organized by CAE and international partners, in which RTU educators were invited to participate). Webinars organized by the CAE were recorded, with more than 400 participants participating online, and the recordings were viewed more than 650 times. Educational events are also organized by the Career Support and Services Unit, providing regular seminars to RTU academic and general staff on the following issues:

- cultural diversity;
- work productivity (time planning, conflict resolution, communication culture, stress management etc.);
- virtual processes and cybersecurity;
- team management;

- critical thinking;
- youth psychology;
- working with students with disabilities;
- burnout at work, etc.

Employees receive professional development certificates for their participation in seminars issued by RTU Department of Further Education.

The themes of seminars and classes are offered taking into account the results of RTU staff surveys, as well as current trends at foreign universities. Information on seminars organized over the years is available at https://www.rtu.lv/lv/studentuserviss/karjeras-centrs-ssc/projekti-un-seminari/seminari-un-vieslekcijas.

RTU IT User Support Centre regularly organizes training on IT systems and the latest technology tools for RTU academic and general staff. Training is organized on the following topics:

- E-learning environment (*Moodle*) for beginners;
- E-learning environment (*Moodle*) for advanced users;
- MS *Outlook* email and calendar;
- *Office365 Teams* and OneDrive;
- Searching in subscribed databases;
- Record-keeping systems;
- Basic IT security issues working with RTU information systems.

In May each year, the Student Parliament of RTU organizes the contest “Annual Award of the Student Parliament of Riga Technical University”. During the event, RTU staff and members chosen by the students are awarded the honorary titles “Instructor of the Year” and “Student Support of the Year”.

To recognize and appreciate RTU academic staff, since 2018, RTU has been organizing contests “Annual Academic Excellence Awards” and “Young Academic Staff Member of the Year” in cooperation with the foundation “Riga Technical University Development Fund” and Industry Service Partner Ltd. The aim of these events is not only to award the best academic staff members, but also to promote creativity in the academic environment.

Since 2019, RTU has been implementing a qualification advancement project in cooperation with the Ministry of Education and Science of the Republic of Latvia and the Ministry of Education of the Republic of Latvia, which provides for the training of academic staff of the leading Latvian universities at the University at Buffalo in the USA. The training programme consists of two parts – (1) to acquire the teaching methodology from the position of the student and (2) to acquire the teaching methodology from the position of the educator. Each of the training stages lasts one semester in the U.S. Currently, there are 8 lecturers in the study field who have undergone or are currently undergoing training.

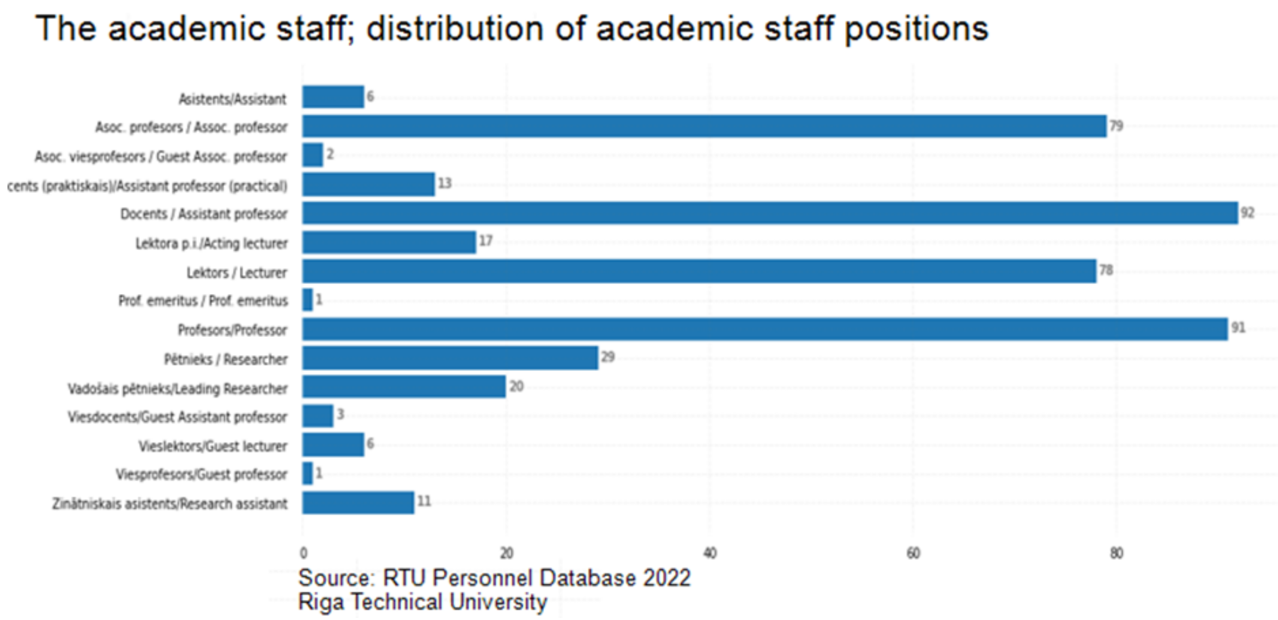
The training has already allowed to improve the quality of studies and the pedagogical methods used, it also provides an opportunity to expand the diversity of academic projects in which the faculties implementing the study field are involved, thus contributing to the implementation of the digital transformation agenda of Latvia.

2.3.7. Provide information on the number of the teaching staff members involved in the implementation of the relevant study programmes of the study field, as well as the

analysis and assessment of the academic, administrative (if applicable) and research workload.

The academic staff consists of 473 members (the composition of the academic staff is time-varying; the report states the situation as of May 2022) are involved in the implementation of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” (the composition of academic staff is changing in time), of which 370 (~ 78%) have been elected to one of the academic positions at RTU, 63 (~ 13%) are employed temporarily in one of the academic positions. The rest are in other types of employment relationships or work in positions that do not require election.

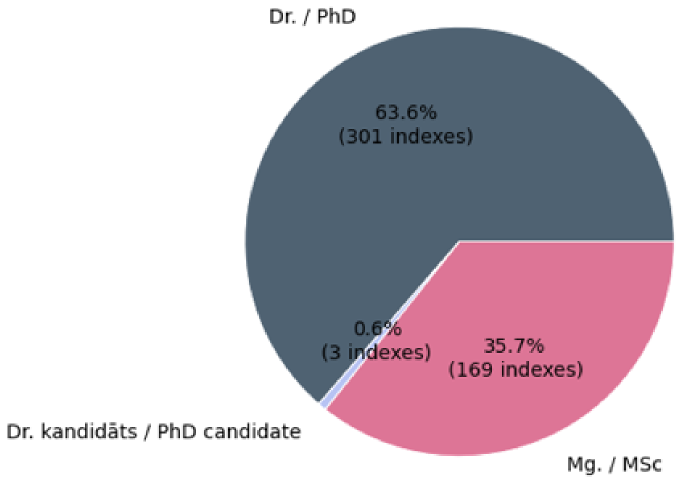
The breakdown by position is shown in the following figure:



As can be seen in the figure representing the distribution by positions, a significant part of the academic staff is made of professors, associate professors and assistant professors, together making up more than half of the academic staff. Of all academic staff, ~16% are lecturers and ~14% are researchers, leading researchers and scientific assistants. The relatively high proportion of employees in scientific positions is due to their active participation in the implementation of research projects, which are usually associated with certain restrictions on holding other academic positions. PhD students who have obtained a Master's degree in the field and devote a significant part of their academic workload to research are also often employed.

Of all academic staff~ 63% are made up of staff with a doctorate in the field of their specialization, while ~ 36% of persons with a Master's degree in the field of their specialization. As can be seen in the figure on distribution by education level, academic staff with a PhD candidate status are also employed. This attest that a student is about to obtain a PhD.

Distribution of education; distribution of education by levels



Source: RTU Personnel Database 2022
Riga Technical University

Determining remuneration and workload for academic (pedagogical) work, administrative work and research (including project) work, the basic principle of integrated planning is used, taking into account the planned amount of work for the current reporting period by the semester or academic year, and making an adjustment for the work done in the previous period. Academic work includes contact hours in auditoriums and laboratories, consultations, supervision and review of study and graduation papers, work in examination committees, methodological work and activities that improve the quality of studies, etc.

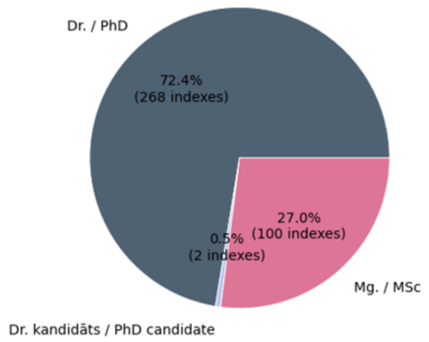
Administrative (organizational) work includes the management of study programmes, work in councils/committees/council/Senate, management of organizational units, etc.

Research (scientific) work includes attraction and management of projects, performance of research tasks, which are paid from development funds or with third party funding (including contracts, contract work with legal persons in Latvia/abroad, etc.), development of publications, supervision and review of PhD Theses, work with PhD students, consulting.

In most cases, it is not possible to strictly delineate and determine the academic and research workload, because on a daily basis the duties of the staff overlap and all elected members of academic staff have both academic and research workload, as well as, in some cases, administrative work. RTU does not strictly delineate academic and research workload. Its proportion for each member of academic staff is determined individually, planning the employee's workload in the department, as well as taking into account their position, involvement in the implementation of projects, their professional competencies and experience.

Of all elected academic staff, ~72% hold a PhD degree and ~27% hold a Master of Science degree, which indicates a significantly higher relative number of PhD holders among the elected staff.

Distribution of education; distribution of education by levels

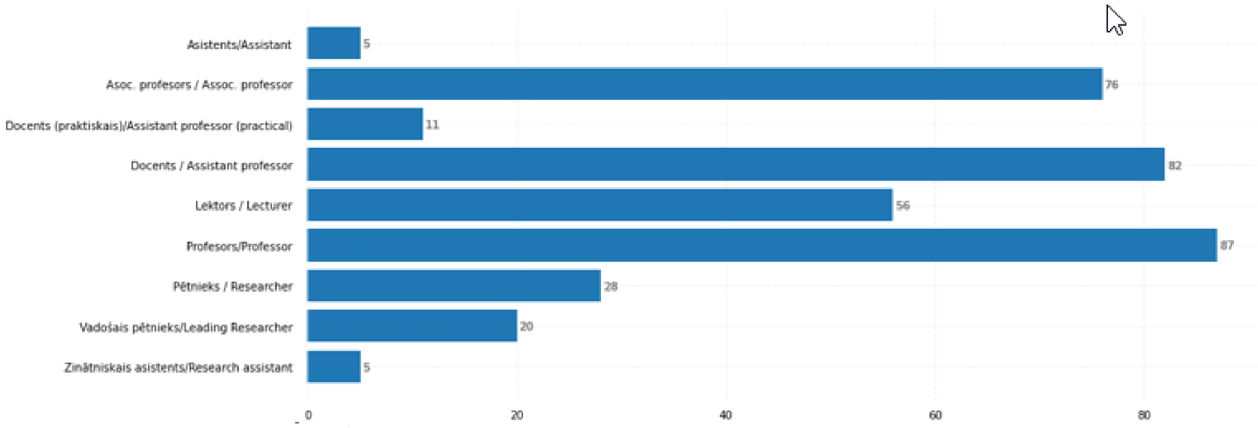


Source: RTU Personnel Database 2022
Riga Technical University

Of the elected academic staff, the majority are lecturers (~15%), assistant professors (~25%), associate professors (~20%) and professors (~23%), which indicates the availability of relatively highly professional academic staff for successful implementation of the study field.

The division among the above-mentioned categories of positions indicates a relatively healthy and steady availability of competences in the study field, as well as a positive process of workforce renewal. This ensures sustainable development of the study field in the future.

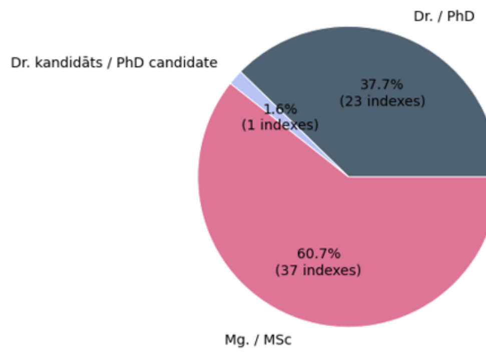
Academic staff; distribution of positions of academic staff



Source: RTU Personnel Database 2022
Riga Technical University

Academic staff from other organizational units and sectors with appropriate professional experience are also involved in the implementation of the study process. In order to ensure a balanced proportion between the content of academic and practical studies within the framework of study courses, as well as the acquisition of high-quality knowledge corresponding to the current business environment in the study process, high-level experts, experienced and successful management professionals from the companies and organizations in the industry are attracted as guest lecturers in the implementation of study courses. The main goal of attracting such academic staff is to increase the quality of the study content and transfer current trends in the field in the study curriculum. At the moment of drawing up the report, 63 temporarily accepted academic staff are working in the organizational units implementing the study field, of which ~38% hold a PhD and the majority or 61% hold a Master's degree. In addition, ~1% of PhD candidates are employed.

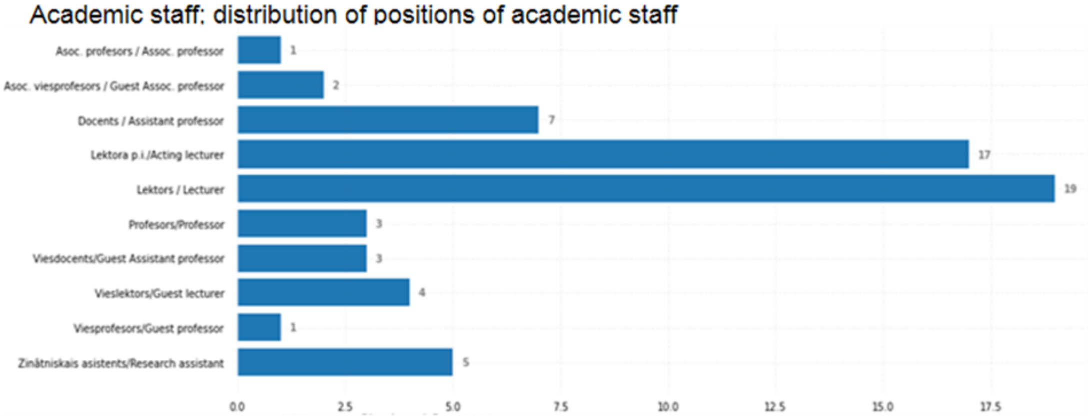
Distribution of education; distribution of education by levels



Source: RTU Personnel Database 2022
Riga Technical University

As it can be seen below, according to the distribution by positions, temporary employees are mostly lecturers (including acting lecturers) and visiting staff, which indicates the dynamics of the academic team, allowing to attract both academic staff from the industry (usually lecturers) and from abroad.

Academic staff: distribution of positions of academic staff



Source: RTU Personnel Database 2022
Riga Technical University

Improving the competences of academic staff by engaging in mobility programmes and attracting foreign lecturers is essential to ensure the quality of the study process. The mobility of the academic staff in the study field is considered to be quite high, and it has taken place in various forms. Many members of academic staff have improved their qualifications by participating in international exchange programmes for academic staff (e.g., ERASMUS+, EEA and others). During the reporting period, academic staff and administrative staff actively participated in international exchange programmes and delivered guest lectures abroad. During the reporting period, there has also been an active recruitment of guest professors (see Section 2.5.3).

A summary of the qualification of the academic staff involved in the implementation of the study programmes in the study field, the study courses implemented, the knowledge of foreign languages is given in Annex *P19_2.3.7_Macibspeki_LV_AcademicStaff_ENG*.

A separate annex *A20_2.3.7_CV_ENG* contains descriptions of the curriculum vitae (CV) of the academic staff. Certifications regarding the knowledge of the official language and foreign language of the academic staff in accordance with the national legislation are appended to the relevant annexes.

2.3.8. Assessment of the support available for the students, including the support provided during the study process, as well as career and psychological support by

specifying the support to be provided to specific student groups (for instance, students from abroad, part-time students, distance-learning students, students with special needs, etc.).

RTU Career Support and Services Department provides students with a wide range of career and psychological support services.

Career development support involves:

For prospective students:

- consultation on study programme selection;
- consultation on study selection and skills profiling;
- career choice seminars within RTU Open Days and upon request.

For the current students:

- regular seminars and individual consultations on the development of career management skills, writing CVs and cover letters, job interview process;
- seminars on the development of entrepreneurial skills;
- project "RTU Golden Fund" to honour the best graduates and to promote new opportunities in the labour market;
- student summer camps for the development of career management and social skills and competences;
- online resource https://ekarjera.rtu.lv/;
- an annual career day aimed at informing students majoring in engineering, natural and social sciences about the best and leading companies in the respective fields and bringing them closer to potential partner companies for undertaking internship and employers.

Psychological support involves:

- individual consultations and support in case of difficulties with studies (time planning, lack of motivation, social anxiety, adaptation difficulties) and individual psychologist consultations on personal issues and difficulties (including crisis intervention).

Seminars and workshops on the following topics:

- adaptation events for first-year students - informative classes within the study course “Introduction to Study Field”, seminars on the development of learning and communication skills;
- stress management methods;
- time planning methods; o self-motivation;
- emotion management and development of emotional intelligence;
- public speaking skills.

Support is differentiated by the target groups (https://www.rtu.lv/en/studentservice/career-centre/psychological-support):

- prospective students (secondary school pupils, vocational school graduates, other prospective students): consultations concerning studies are available, including skills diagnostics.
- first-year students: informative classes within the framework of the study course “Introduction to Study Field”; seminars on the development of learning skills; information

letters on career and psychologist support opportunities; individual career and psychologist consultations; and other activities in cooperation with businesses and non-governmental organizations.
- all RTU students: individual career and psychologist consultations, seminars and classes, guest lectures, RTU Career Day.
- foreign students (*Erasmus+* mobility and full-time): individual and career support consultations are available in English; wherever possible, seminars and classes are conducted in English, such as seminars on writing CVs and cover letters, time management.
- students with special needs: psychological and career support consultations are provided upon request; physical access to the room; opportunity to come with one's mentor or interpreter.
- graduates: career support consultations are provided if necessary; consultations on writing CVs and cover letters, job interview process, career opportunities.
- staff: consultations on work and study related issues are provided to RTU academic and general staff members, if necessary.

As a result of COVID-19 pandemic, the offer has become even more accessible, as counselling and also career classes can be offered remotely.

In 2014, the Student Services Centre was opened in Ķīpsala Campus. It ensures day-to-day support under the supervision of the Career Support and Services Department:

- provides answers to various questions that students may have;
- provides printing, copying and binding services;
- issues identification cards;
- draws up references and transcripts, if necessary.

Further information is available at: https://www.rtu.lv/en/studentservice/student-service.

In 2019, work was started on strengthening support for students with disabilities and in 2020 guidelines were issued with recommendations for effective communication and improvement of the study environment for people with disabilities and special needs: https://www.rtu.lv/lv/studentuserviss/par-mums-ssd/noderigi-ssc/noderigi-materiali-1/ka-komunicet-un-nodrosinat-piemerotu-studiju-vidi-personam-ar-invaliditati-un-specialam-vajadzibam (only in Latvian).

RTU International Cooperation and Foreign Students Department has academic consultants who consult foreign students on studies and practical issues. Academic consultants keep track of the students' academic performance and attendance, as well as meet students on a regular basis to make sure their studies are successful, both in and outside the classroom. Shortly after the arrival of students, academic seminars are held, which are compulsory for all new students. Academic seminars are held approximately twice a week at the beginning of each semester, in line with the student influx. During these seminars, academic consultants introduce students to RTU internal rules, their responsibilities and rights, academic integrity, and various other practical aspects. In the future, it is planned to divide the students into groups according to the study programmes and to involve the heads of the study programmes in the seminars so that the students would get acquainted with the management of the programmes in due time. If during the semester a student is observed to face difficulties with the study process (attendance, academic arrears), the student is invited to an individual meeting with his/her academic consultant to discuss the best possible solutions to the problem. Each academic consultant has to arrange meetings with 2-5 students per week. After a month, students are invited to the meeting again to discuss their progress and make sure the situation has improved.

At RTU International Cooperation and Foreign Students Department, students have a contact person for facilitating the immigration process. The contact person organises immigration seminars and document examination at the beginning of the semester. The Department arranges an appointment for students with the Office of Citizenship and Migration Affairs of the Republic of Latvia.

Employees of RTU ICFSD International Student Admissions Group organize virtual seminars for international students, which take place before the beginning of the academic year / semester and students enter Latvia in order to inform students about practical issues related to entering and staying in Latvia (entry requirements, vaccination, self-isolation, accommodation, etc.)

ICFSD in cooperation with the Student Service provides international students with their career counsellor, who explains employment-related issues to the students and introduces them to the available vacancies, thus facilitating students to gain work experience and develop their skills and abilities.

In order to ensure cooperation with the students of different groups and the possibility to acquire study courses remotely or in a hybrid mode, the faculties implementing the study field have made a systematic contribution to the improvement of technical support by equipping study rooms with video and sound recording equipment, as well as with online streaming equipment. In the newly built FCSIT building, appropriate equipment has been installed in the auditoriums.

In order to promote the creation of an inclusive study environment, the faculties implementing the study field in Kipsala Campus have been equipped for the admission of students with reduced mobility:

- the main entrances provide access to buildings for wheelchair users;
- in order to access the “Domus Auditorialis” conference center, an appropriate elevator has been built;
- persons with reduced mobility have specially equipped WC facilities;
- in the auditoriums the width of the door is appropriate;
- easy access to the canteen and movement between buildings is ensured without leaving the buildings in the yard via air passages.

Every year, student unions of the study field organize several unification events:

- Annual FCSIT and FET first year student consolidation event before starting studies at the end of August. The event includes sports and ingenuity competitions, as well as entertaining cohesive events. A mandatory part of the event is a sports session led by the deans of faculties with the slogan "Healthy body, whole spirit".
- FCSIT Student Union organizes "Sēta" Days, during which a social event with music, snacks and fun activities for all visitors is organized in the faculty yard.

FET and FCSIT student unions, in cooperation with LETERA and faculty administrations, organize robotics competitions, which is already a well-known Latvian-wide robotics enthusiast festival.

2.4. Scientific Research and Artistic Creation

2.4.1. Description and assessment of the fields of scientific research and/or artistic creation in the study field, their compliance with the aims of the higher education institution/ college and the study field, and the development level of scientific research

and artistic creation (provide a separate description of the role of the doctoral study programmes, if applicable).

RTU Strategy defines research excellence as one of the pillars of development in order to achieve the set goals and objectives while implementing the Strategy. Therefore, in accordance with the effective regulation (RTU Senate Decision No. 594 “On RTU Regulations on the Procedure for Election of Professors and Associated Professors” after approval of the new revision, approved on 30 November 2015), performance of professors and associate professors are re-evaluated every six years. In addition, in accordance with Section 34 of the Law on Higher Education Institutions and RTU Rector’s Order No. 01000-1.1-e / 157 of 7 October 2021, at least once every two years professors and associated professors together with the heads of their organizational units carry out internal assessment of their scientific and pedagogical activities, as a result, recommendations are made and an action plan for successful career development and compliance with the above requirements is developed in cooperation with RTU Personnel Management Department.

In order to manage career development of the staff and the achievement of the goals of the RTU Strategy, every year the Rector and the Faculty deans sign agreements where each faculty undertakes to achieve the main stated performance parameters. Depending on the achieved indicators, adjustments are made to the performance-based funding, which allows managing the development process and promoting it in the necessary areas. A significant part of these indicators is related to scientific activity, including the number of publications, their citation index, the amount of attracted research funding, valorization indicators, a set of other measures and indicators.

Taking into account the rapid development of scientific thought and the emergence of new research areas, RTU has the opportunity to attract so-called tenured professors who would contribute to the development of specific new or existing research fields. At the time of drawing up the report, RTU has a valid regulation, which was adopted by the decision of the RTU Senate of 25 April 2022, determining the payment procedure, requirements and regular inspection mechanism in the activities of the tenured professors.

In order to promote the development of the scientific school of RTU, the supervisors of the scientific works of the future scientists (PhD students) must meet certain requirements, which are determined by Decision of the RTU Senate No. 602 “On Amendments to Riga Technical University Regulations of Doctoral Studies”, approved on 26 September 2016. The regulation requires that the supervisors of PhD theses obtain the status of an expert granted by the Latvian Council of Science. Expert database is published in the National Research Information System (NRIS; http://sciencelatvia.lv).

Two enabling mechanisms have been put in place for the development of PhD research in addition to the generally available support:

- Doctoral research grants by RTU Senate decision No. 01000-1.2-e/53 of 26 December 2021, which determines the type and amount of funding for research, as well as the results and deadlines to be achieved.
- Industrial PhD program, which is formally implemented through tripartite agreements between a particular company, PhD student and RTU, which allows developing research in the areas important to the company, thus contributing to the increase of its know-how, knowledge and competitiveness, as well as providing 50% of the costs of the total PhD costs in this program. The other 50% is covered by the organizational unit of RTU, which has proposed research within this programme.

There are several support mechanisms for the involvement of academic staff in scientific activities, the most important of which are RTU Research Support Fund and Research Platforms.

The goal of RTU Research Support Fund (RTU Senate Decision No. 585 “Regulation on RTU Research Support Fund”, approved on 15 December 2014) is to provide financial support to different research related activities, for example, finance research equipment maintenance, protect and license intellectual property, cover the costs of PhD studies, publish scientific journals, visit and organize scientific conferences, support researchers in establishment of new advancer research laboratories. The Research Support Fund is a research activity support tool, which stimulates the development of strategic fields of research.

In 2013, at RTU level six research platforms were founded for RTU dominating strategic research fields as a tool for promotion cross-disciplinary and cross-faculty researcher cooperation in the fields of industrial and social relevance. These platforms include: “Energy and Environment”, “Cities and Development”, “Information and Communication Technologies”, “Transportation”, “Materials, Processes and Technologies”, “Safety and Security”. The faculties represented within the study field and their researchers participate in all research platforms, which allows providing the horizontal impact on their development, as well as using the opportunities for cooperation with other study fields. Each platform is assigned a certain coordinator, and together they form the Coordinator Board being in charge of implementation of the activities within the platforms. The Board is accountable to the Office of Vice-Rector for Research (RTU Senate Decision No. 600 “On Approval of the Regulation for Riga Technical University Research Platform Coordinators” of 23 May, 2016). Similar to the faculties, the platforms have their own research programme (RTU Senate Decision No. 590 “On Authorization of RTU Research Council to Approve RTU Research Program”; “Riga Technical University Research programme for 2016–2020” of 27 May, 2015), annual action plan and financing by the Research Support Fund. Internal project tenders are organized on the annual basis, allocating for this purpose 90 –120 thous. EUR to the winning projects. The compulsory requirement to projects is 20 % co-financing from an industrial sector and participation of more than one faculty. In the period from 2016 to 2018 this way 33 projects received funding in the total amount of almost 275 thous. EUR. The framework of the research platforms supposes regular seminars for better transfer of expertise, field trips to companies aimed at promotion of networking opportunities and cooperation with the industry experts, as well as other relevant activities.

Efficiency of these mechanisms can be illustrated by growth of SCOPUS indexed publications in the period of 2013–2019. The total number of the publications increased from approximately 440 publications per year in 2013 to 865 in 2018. Number of SCOPUS publications per researcher (expressed in full-time-equivalent (FTE)) increased from circa 0.9 in 2013 to circa 1.5 publications/FTE per year in 2018 (the data were obtained from Elsevier “SciVal” database on 17 June 2019).

Research and creative activity of the study field is carried out in accordance with the principles of academic freedom, promoting the achievement of the strategic aims of the participating faculties. Each of the faculties has specific research areas:

FCSIT:

- Mass computing-rooted decision-making for growing companies of the digital age (general purpose information systems);

- Comprehensive intelligence for smart and autonomous systems and their integration (artificial intelligence and robotics);

- Transparent data processing (communication, computing and management) in complex and distributed environments (business information systems);

- Mathematical modeling.

FET

- Data transmission systems (optical, wireless and quantum fiber) and their functional elements;
- Metaphotonics solutions in optical communications and sensor technologies;
- Energy efficient solutions for high-security wireless sensor networks.

FETH

- Digital humanities
- Terminology and terminotics
- Interdisciplinary research in humanities
- Linguistics, technical translation and machine translation;
- Interdisciplinary research in e-learning technologies and social sciences.

RBS

- Mathematical modelling, business statistics and financial risk management;
- Strategic management of organizations, project management and digital transformation.

Scientific research is concentrated in the structural units of the faculties – departments, laboratories or research groups established for a specific purpose, which are focused on the performance of specific tasks. PhD students of the study field have been the first (FET and FCSIT) to start research within the framework of the Industrial Doctor Program, thus paving the way for young researchers from other fields at RTU.

In addition to the mentioned study field, academic staff is active in the Doctoral Councils of RTU and other higher education institutions, expert councils, as well as act as visiting academic staff and visiting researchers, thus improving their pedagogical and scientific skills.

2.4.2. The relation between scientific research and/or artistic creation and the study process, including the description and assessment of the use of the outcomes in the study process.

The study field is characterized by the largest number of students, the largest academic capacity and scientific contribution, providing education to ~ 3000 students, of whom ~ 20% are international students. ~ 150 of the total academic staff are elected academic staff. The aim of the study field is to achieve excellence in studies, scientific research, high-quality and sustainable innovation, as well as to make an excellent contribution to the implementation of general RTU Strategy.

The implementation of strategic goals of research excellence has resulted in the high evaluation received by the largest faculty of the study field (FCSIT) in the International Evaluation of Scientific Institutions - 4 *(The International Evaluation of Scientific Institutions' Activity Self-Assessment Report, FCSIT 2019 (please, see as an annex E15_RTU_FCSIT_2.4.2.pdf))*. It describes the FCSIT as an important international scientific institution with a significant contribution to the Latvian and regional economy as a whole.

In order to promote the development of the scientific school and increase contribution, the organizational units involved in the implementation of the study field have set several common development goals:

- To significantly increase the intensity of cooperation with the industry, which is reflected both in the amount of funding attracted for research and innovation and the total number of cooperation projects and the proportion of staff involved in research.
- To establish new laboratories and scientific infrastructure or improvement of the existing infrastructure with the aim of ensuring its joint use, as well as the possibility to use it remotely in support of hybrid studies and research.;
- To increase the quality and volume of the existing scientific contribution with the aim to strengthen the international recognition of the faculties involved in the implementation of the study field and the development of scientific thought. The achievement of the objective is related to the increase in the number of citations of publications, as well as investment in the fields of fundamental research.
- To increase the number of PhD candidates and students who obtain a PhD, which at the same time supports sustainable development of the study field and increases scientific capacity.
- To develop prospective research areas with the involvement of tenured professors in the organizational structural units, which at the same time will allow developing and improving study courses and pedagogical methods corresponding to the respective fields of research.
- To intensify innovation and technology transfer processes, which promotes the establishment of long-term cooperation between the industry and RTU, as well as allows improving the skills and abilities of the existing academic staff for the commercialization of the obtained research results.

The interdisciplinary role of research is ensured by engaging in the work of RTU Research Platforms, the aim of which is to provide interfaculty, interdisciplinary research in the areas of significance to the national economy and society. Research platforms are a cooperation coordination mechanism, the task of which is to analyze the needs of enterprises and various state institutions in order to define potential research fields according to RTU competencies, to organize relevant internal project competitions, applications for international projects, cooperation with companies and state institutions.

Linking of scientific research with the study process is ensured by using available principles of knowledge transfer and continuous improvement of competences, which is manifested by integrating research results into study courses and study process, involving students in research, introducing students to current research results, enabling them to perform research activities independently and in cooperation (in group work). Linking science and research with the study process is also ensured by the involvement of guest lecturers in the lectures and practical classes, with students actively participating in international conferences and seminars, drawing up international scientific publications and participating in international cooperation research projects.

The study field provides several items of research infrastructure and prototyping objects, which are also used in the study process, for example, for the development of graduation papers, for student research needs, as well as in research carried out jointly with the academic staff. The most important objects are the following:

- RTU Design Factory provides rich possibilities for prototyping and for conducting various measurements.
- FCSIT IKSA Center provides materials, measuring equipment, robot, electronics and software prototyping capabilities, as well as various ready-to-use platforms for conducting research.
- RTU HPC Centre intensively used in the framework of PhD and applied research.
- FCSIT Virtualization solution is used in the research and student projects, making it relatively easy to create such software and hardware virtualized solutions that are relatively easy to

manage and are scalable.

- Computer graphics and photogrammetry equipment is used for the operation and development of virtual and augmented reality solutions, as well as digital twin solutions.
- FCSIT building IoT laboratory – the building is equipped with sensors of environmental parameters that allow students and researchers to approbate various data analysis and forecasting solutions. Students also participate in the installation and configuration of equipment at different stages.
- Plagiarism control laboratory is used in the study of text analysis methods, as well as to improve the quality of studies.
- FET Wireless sensor network and programmable radio laboratory is equipped with tools that allow measurements in RF and microwave frequency ranges.
- The Latvian Electronics Equipment Testing Centre (LEETC), located in FET premises, offers consultations and complex testing services in the field of electromagnetic compatibility in accordance with more than 25 European Union standards and directives.
- FET Electroacoustic Laboratory is a unique laboratory in the Baltics, equipped with an echoless camera, which is used for sound distribution and generation research.
- FET Prototyping Laboratory is equipped with hardware for prototyping electronics and smart systems, including SMD component soldering equipment and PCB Milling Machine.
- RTU Communication Systems Technology Research Centre (RTU ComTech) provides the infrastructure, materials, measuring equipment and components of modern fiber optic and wireless network transmission systems for research carried out by students, development of Bachelor's, Master's and PhD level papers, development of new innovative technologies and solutions. Students are actively involved in the research activities carried out by the Centre, approbation of the obtained scientific results in international scientific conferences and high-level scientific journals.
- FET Telecommunications Institute Internet of Things (IoT) Laboratory – established in cooperation with the company Siemens Latvija. Students acquire knowledge and skills about various industrial IoT solutions, sensor network creation, programmable logic controllers and microcontrollers, data aggregation and processing in the IoT cloud platform Siemens MindSphere.
- Transport Network Performance Assessment and Radio Navigation Laboratory of the FET Institute of Telecommunications is equipped with all the necessary equipment that allows the development of telematics systems for transport and the performance assessment, modelling and analysis of transport networks. Students carry out the development of Bachelor's, Master's and PhD theses. Created in cooperation with the company Ltd “Mikrotīkls”.

All these research infrastructure objects are used for both studies and research and are financed from the total scientific revenue, as well as the revenue from contracted research. Students and researchers collaborate on various projects, some of which are listed in the following list:

No.	Project	Description
1.	**Robocom++** H2020 EraNet+, 2016 – 2019 (robocomplusplus.eu)	Within the framework of the project, methods of cooperation of many robots and their demonstration systems were developed. Several students of the study programme Intelligent Robotic System participated in the project, in cooperation with leading researchers of the FCSIT.

2.	**iFast** 2021 – until present Research cooperation project with CERN. (https://ifast-project.eu)	Research project in cooperation with CERN for the development of high-speed machine learning embedded algorithms, for processing experimental data flows. Both researchers and PhD students are involved in the project. The project has gained international recognition.
3.	**IoT-Open.EU,** 2016 – 2019 (IOT-OPEN.EU) H2020 Erasmus+ project	Within the framework of the project, university study materials on the Internet of Things and electronics have been developed. In addition, an international network of remote laboratories has been developed, accessible to partner universities, their students and researchers. PhD, Master and Bachelor students were involved in the development of the materials. The materials have been introduced into the study process, and the project was generally recognized as the best in the program. A follow-up IoT-Open.EU Reloaded has been submitted to the project, which is evaluated during the drawing up of the report.
4.	**Autonomian,** 2018 – 2021 (Autonomian | Facebook), H2020 Erasmus+ project	The project focused on the development of learning materials in the field of autonomous systems, during which vocational education institutions were also involved, thus contributing to the exchange and development of pedagogical thought. Both students and experienced researchers were involved in the project with the aim of improving the existing study materials by including topical themes in the field of autonomous systems.
5.	**KC-PI-2017/57 "Multiple robot systems for cleaning industrial premises" -** LIAA commercialization project, 2018. – 2021., Daudzu robotu sistēmas industriālu telpu uzkopšanai - Inovāciju un tehnoloģiju pārneses centrs (rtu.lv)	Within the framework of the project, many-robot technology has been developed for industrial cleaning tasks. The results of the project have been successfully commercialized and are used for the development of Ltd RoboticSolutions. The result of the project is a company that has successfully attracted several stages of investment. Students are actively involved in the implementation of the project and several Bachelor and Master Theses have been defended on the important project themes.

6.	**"Donut resonator modulators for optical interconnections" (RINGO),** ERDF interdisciplinary project, 2022 – 2023	The project envisages the development of an energy-efficient optical transmitter for optical interconnections based on a doughnut resonator modulator using silicon to insulator technology, which will allow increasing the capacity of optical interconnections. The project involves both students and experienced researchers.
7.	**"Development of efficient casing-pumped fiber optic amplifiers for telecommunication systems" (DOPAnT),** ERDF interdisciplinary project, 2019 – 2021	Within the framework of the project, it is planned to develop broadband optical amplifier using different alloy fibers and efficient shell pumping technique in order to achieve large and uniform reinforcement and improve performance of fiber optic communication systems.
8.	**"Passive fiber optical sensors for energy efficient monitoring of the technical condition of transport infrastructure",** ERDF interdisciplinary project, 2017 – 2020	Within the framework of the project, it is planned to develop new energy efficient fiber-based Brega grid (FBG) based optical sensors and solutions of the optical signal processing system coming from them for continuous monitoring of the technical condition of roads and embankments. Both researchers and PhD students are involved in the project.
9.	**"Cyber-physical systems, ontology and biophotonics for a safe&smart city and society" (VPP SOPHIS),** Latvian National Research Programme No. 10-4/VPP-4/11, 2014. – 2017.	The overall objective of the project is to develop world-class competence in the field of "smart" urban technologies, which can be used to monitor the environment and urban infrastructure in order to provide residents with a safe and reliable living environment, thus creating the basis for the creation of competitive services and products. The results of the project have been presented at several international conferences; several patents of the Republic of Latvia have been drawn. Students are actively involved in the implementation of the project and several Bachelor and Master Theses have been defended on the important project themes.

10.	***“Development* of *optical frequency comb generator based* on a *whispering gallery* mode *microresonator* and *its applications* in *telecommunications*” (WCOMBs),** ERDF interdisciplinary project, 2019 – 2022	The aim of the project is to gain new knowledge about the optical frequency combs (WCOMBs) of whispering gallery mode resonators and to develop, construct and test a prototype comb generator for telecommunications applications. The project promotes the implementation of the economic transformation and the development of the growth priorities and specialization areas set out in the Smart Specialization Strategy of Latvia. Both researchers and PhD students are involved in the project.
11.	**“Control of computer network traffic using machine learning techniques”,** ERDF project, 2018 – 2021	The scientific objective of the project is to carry out a study on the application of modern machine learning methods in the analysis and control of computer network traffic, which would allow performing the most efficient exchange of information – transmitting data at shortest intervals and/or improving the quality of the user experience. Both researchers and PhD students are involved in the project.

As can be seen from the presented list of the most significant projects, students and researchers cooperate within the framework of various projects, which in its turn helps develop scientific thought, study curriculum, pedagogical methods, as well as promotes labor supply and know-how in the areas important for the Latvian economy.

Currently, the organizational units forming the study field have been actively involved in the application and subsequent implementation of SSO 14.1.1.1 and subsequent projects dedicated to the implementation of the Latvian digital agenda. The project plans to develop the shared research and study infrastructure, significantly expanding the set of digital study and research tools available in Latvia.

In general, the increasing publication citation indicators, the amount of funding attracted and the registered objects of intellectual property, which ensure strenuous and sustainable development of the study field as a whole, testify to successful synergy between studies and science.

2.4.3. Description and assessment of the international cooperation in the field of scientific research and/or artistic creation by specifying any joint projects, researches, etc. Specify those study programmes, which benefit from this cooperation. Specify the future plans for the development of international cooperation in the field of scientific research and/or artistic creation.

Taking into account the important role of the study field in the Latvian economy, as well as the relatively large number of employees involved in the academic and research work, international cooperation in research is also relatively active, which has resulted in the implementation of about 300 different types of projects in the reporting period. In this period, a significant amount of contracted work of various types of applied research has been implemented, which has allowed attracting a considerable funding, as well as expanding cooperation with the representatives of the Latvian and foreign industry. In addition, the projects have allowed involving students in research, thus increasing their know-how and interest in research, which provides additional motivation for successful continuation of studies in the subsequent education cycles.

The following major projects have been implemented within the framework of the study field:

Projects of the National Research Programme (SRP)	
2014 – 2017	**Program:** NRP – National Next Generation Information and Communication Technology (ICT) Research Programme - NextIT **Project:** Biometrics, biosignals and non-invasive non-contact diagnostic technologies RTU – partner, in cooperation with Ventspils University of Applied Sciences (VUAS) and UL MII
2014 – 2017	**Program:** NRP – National Next Generation Information and Communication Technology (ICT) Research Programme - NextIT **Project:** Biometrics, biosignals and non-invasive non-contact diagnostic technologies RTU – partner, in cooperation with VUAS and UL MII
2014 – 2017	**Program:** NRP – Cyber-physical systems, ontologies and biophotonics for safe&smart city and society - SOPHIS **Project:** Ontology-based knowledge engineering technologies suitable for web environment RTU – partner, in cooperation with EDI, UL MII
2014 – 2017	**Program:** NRP – Cyber-physical systems, ontologies and biophotonics for safe&smart city and society - SOPHIS **Project:** Technology for a safe and reliable smart city RTU – partner, in cooperation with EDI, UL, MII, LU
2018 – 2021	**Program:** The Latvian language **Project:** The Latvian language RTU – partner, in cooperation with UL, LVA, DU, VUAS, RTA, UL MII
2020	**Program:** Mitigation of COVID-19 consequences **Project:** Establishment of COVID-19 related biobank and integrated platform for research data in Latvia RTU – partner, in cooperation with LBPSC, RSU, UL
2020	**Program:** Mitigation of COVID-19 consequences **Project:** Integration of reliable technologies for protection against Covid-19 in healthcare and high-risk areas RTU – leading partner, in cooperation with EDI, RTA
2020	**Program:** Digital Resources in the Humanities **Project:** Digital Resources in the Humanities: integration and development a RTU – partner, in cooperation with UL, UL MII, LNB, RTA, LiepU

2020	**Program:** Mitigation of COVID-19 consequences **Project:** Emerging technologies for sustainable and secure services RTU – leading partner, in cooperation with VA, UL, RTA, LiepU

Within the framework of the National Research Program, the development of scientific fields important for the Latvian economy is promoted by cooperating with research institutions and centers of national significance. As a result of the cooperation, the main achievements are published in internationally recognized and cited publications, thus facilitating integration of the researchers involved in the projects into international scientific discussion.

EC Framework Programmes	
2007 – 2013	**Program:** EC, Interreg, Lat-Lit **Project:** Synergetic approach with eLearning, TV and mobile technologies to promote new business developments (https://keep.eu/projects/7700/Synergetic-approach-with-eLe-EN/)
2012 – 2014	**Program:** EC, Interreg, Lat-Lit **Project:** Truffle research and introduction network for farmer start-ups and universities (https://www.llu.lv/lv/projekti/apstiprinatie-projekti/2012/truffle-research-and-introduction-network-for-farmer-start-ups)
2013 – 2016	**Program:** EC 7th FP **Project:** Information management system as an effective tool for *in vitro* diagnostics standardization
2016	**Program:** EC 7th FP **Project:** Capability as a service in digital enterprises (CaaS) (https://cordis.europa.eu/project/id/611351)
2016	**Program:** EK H2020 FLAG-ERA **Project:** Future ICT 2.0 (https://futurict2.eu/the-project-2/)
2013 – 2015	**Program:** EC 7th FP **Project:** ICT Transfer Concept for Adaption, Dissemination and Local Exploitation of European Research Results in Central Asia's Countries. eINTERASIA (https://cordis.europa.eu/project/id/600680)
2017 – 2020	**Program:** EC H2020 FLAG-ERA **Project:** Rethinking Robotics for the Robot Companion of the future (https://www.era-learn.eu/network-information/networks/flag-era/flag-era-jtc-2016/rethinking-robotics-for-the-robot-companion-of-the-future?SearchTerm=Robocom)
2021 – 2025	**Program:** EC H2020 ECSEL IA **Project:** Challenging environments tolerant Smart systems for IoT and AI (https://cordis.europa.eu/project/id/876362)
2021 – 2024	**Program:** EC H2020 **Project:** Diagnosis of endometriosis through machine learning
2021 – 2025	**Program:** EC H2020 **Project:** Innovation Fostering in Accelerator Science and Technology (I-Fast) (https://cordis.europa.eu/project/id/101004730)

The projects of the EC framework programmes allow faculty researchers to join international research consortia and contribute to the scientific development of the European and global scope, thus improving their scientific research skills and updating research fields. In addition, such studies provide an opportunity to raise visibility, improve research methods and infrastructure.

EC cooperation, coordination and academic projects	
2013	**Program:** EC, ERASMUS **Project:** Future Education and Training in Computing: How to Support Learning at Anytime Anywhere
2014	**Program:** EC, ERASMUS+ **Project:** Cooperation for innovation and the exchange of good practices (https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2014-1-DK01-KA203-000764)
2016	**Program:** EC, ERASMUS+ **Project:** Innovative Open Education on IoT: improving higher education for European digital global competitiveness (https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2016-1-PL01-KA203-026471)
2018	**Program:** EC, ERASMUS+ **Project:** A digital package for autonomous systems and self-driving vehicles (https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2018-1-EE01-KA202-047111)

2020	**Program:** EC, ERASMUS+ **Project:** Cybersecurity Curricula Recommendations for Smart Grids (https://erasmus-plus.ec.europa.eu/projects/eplus-project-details#project/2020-1-FI01-KA203-066624)

Cooperation projects within ERASMUS+ and other programmes make a significant contribution to the improvement of the study environment and curriculum, as well as strengthen or re-establish networks for the joint implementation of research projects.

In addition to the projects mentioned above, more than 30 grant projects of the Latvian Council of Science, more than 120 industry-funded contracted research and cooperation projects have been implemented, including EUREKA programme projects, Competence Centre projects, LIAA innovation grants and ERDF applied research programme projects.

The impact of research projects on the study field is manifested in the achieved scientific activity performance indicators:

- The Faculty of Computer Science and Information Technology, which implements the study field, has obtained a high rating (4 out of 5) in the International Evaluation of Scientific Institutions, which puts it in the list of institutions with significant regional influence.
- During the reporting period, the total number of publications has increased by ~15%, of which ~20% are open resource publications.
- There has been a significant increase in research funding amounting to several million euros per year. This has also led to an increase in the amount of base (Pillar 1) and performance-based funding (Pillar 2).
- The number of young researchers has increased, as well as the number of studies carried out together with foreign colleagues, which has allowed developing research capacity and expanding research themes.
- The number of contracted research and the amount of revenue related thereto has increased significantly, which indicates the conformity of the research carried out within the framework of the field with the global trends, the needs of the Latvian economy, as well as the increasing trust between companies in the sector and research groups in the study field.

Project results have a significant impact on the study programmes of the study field, because these results and insights are integrated into the study courses and provide additional experience and skills to the students involved in the projects. The projects mainly involve academic staff and PhD students who are responsible for the study process and the study courses implemented therein. Participation in the projects allows PhD students and scientists to provide students and other scientific research participants with new and up-to-date knowledge, thus motivating students to engage in research and continue studies in the next education cycle. It helps develop skills to independently and critically analyze project results and developed solutions that can be used in the respective research fields for solving important tasks and creating and managing independent projects.

As indicated above, the organizational units implementing the study field are active in the implementation of academic and cooperation projects, including ERASMUS + program. The main projects implemented within the programme are aimed at the development of advanced digital skills and integration of appropriate study methods in the study field. Some of the most important methods include the use of remote laboratories in the study process, which provides an opportunity for students of the Latvian and other higher education institutions to use the laboratory at their convenience, for example, to develop a software code, integrate it into remote laboratory hardware and observe the execution of the code. Such methods make it possible to significantly increase the capacity and accessibility of laboratories for students. In order to follow the current trends, MOOCs (Massive Open Online Course) developed within the projects are run using the RTU e-learning platforms and edX (https://www.edx.org/) platforms, focusing on the modern content and methods. Such approaches are in line with the guidelines of Horizon Europe Digital Europe Programme (https://digital-strategy.ec.europa.eu/en/activities/digital-programme), as well as Latvia's digital skills development agenda and project program.

The results of several projects are directly integrated into the study process, including the mentioned demonstration system developed by RoboCom++ that is used in the development of graduation papers, the data processing models of IoT systems developed as a result of several contracted studies are introduced into the infrastructure management processes of the FCSIT, turning it into a "living" teaching and research laboratory. Students of particular study programmes participate in the establishment of the laboratory, implementing the development of project-type courses and introducing them at the faculty.

Future plans for the development of international cooperation are related to the development of the existing initiatives, emphasizing the horizontal nature of the research areas characteristic of the study field, thus contributing to the development of interdisciplinary research fields and studies. In accordance with the strategies of the organizational units implementing the study field and the common RTU Strategy, the activities in the study field will focus on: (1) the purposeful development of the academic and research infrastructure aimed at external cooperation and openness to the national and international scientific community, (2) consolidation of research in the areas characteristic of the study field, strengthening them, or expanding them along with the attraction of the tenured professors and young researchers, (3) strengthening cooperation with the enterprises of the industry in Latvia and abroad through Horizon Europe ECSEL, EUREKA, ERASMUS and COST programmes, (4) improvement of post-graduate study programmes supplementing and updating their curricula, incorporating the findings in the field and ensuring the transfer of scientific knowledge and research results in the study process to the degree possible, thus strengthening the research school, (5) strengthening research capacity by increasing the number of young researchers and PhD students working within the framework of industrial PhD studies.

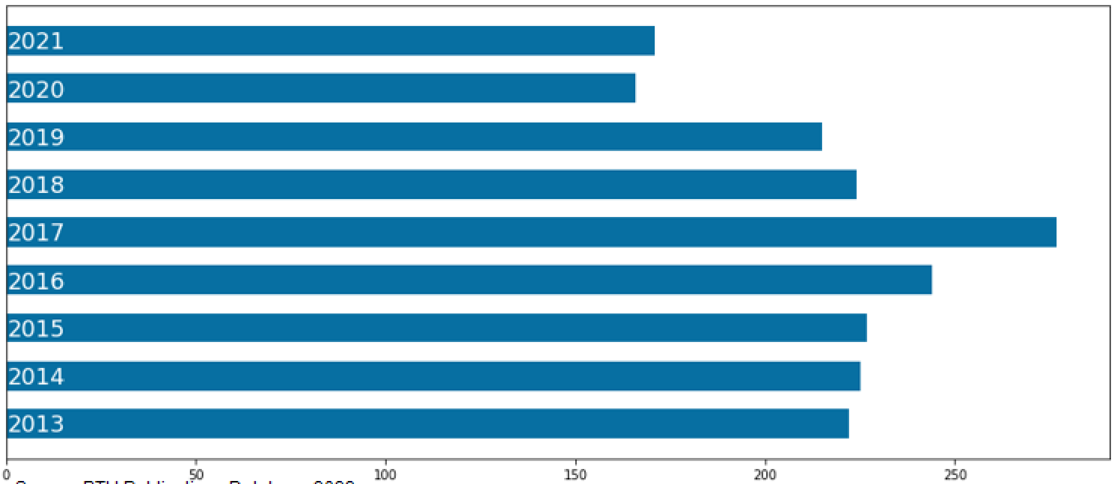
2.4.4. Specify the way how the higher education institution/ college promotes the involvement of the teaching staff in scientific research and/or artistic creation. Provide the description and assessment of the activities carried out by the academic staff in the field of scientific research and/or artistic creation relevant to the study field by providing examples.

According to the RTU requirements, apart from their involvement in the study process, academic staff should be actively involved in research. Professors and associate professors are re-evaluated and re-elected every six years. Candidates shall meet certain criteria in terms of scientific research, i.e., the number of publications or patents, supervised PhD candidates, etc. (Decision of the RTU Senate No. 649 "On Approval of the RTU Regulations "On the Procedure for Election of a Candidate for the Position of Professor or Associate Professor and the Procedure for Assessing the Qualification of an Existing Professor or Associate Professor" in a new edition" as of 26 April 2021). The rights to supervise development of PhD Theses are granted if the members of the academic staff are certified experts in their fields, which is possible only if certain criteria regarding the number of publications/patents are met (Decision of RTU Senate No. 602 "On Amendments to RTU Regulation on Doctorate" of 26 September 2016). The expert status is granted by the Latvian Council of Science. The database of the experts is published on the National Research Information System (NRIS; http://sciencelatvia.lv).

RTU Research Support Fund (decision of RTU Senate No. 585 “RTU Regulation of Research Support Fund” as of 15 December 2014) aims at providing financial support for various research related activities, such as support for maintenance of research equipment, protection and licensing of intellectual property, covering of expenses related to the Doctoral study process, publishing of scientific journals, participation and organization of scientific conferences, support to researchers in establishing new laboratories in a prospective research field. The Research Support Fund is an instrument to support research activities, which foster the development of the strategically important research fields.

RTU personnel development strategy is based on the comprehensive development of the academic staff, which implies their involvement in scientific research and innovation. The organizational units implementing the study field conduct regular evaluation of the workforce and implement measures for advancement and development of academic staff, which has allowed improving the research indicators in general. During the reporting period from 2013 to 2021, academic staff of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” have published their research results and other academic results in ~2000 publications. Breakdown of the publications by year is given in the figure below:

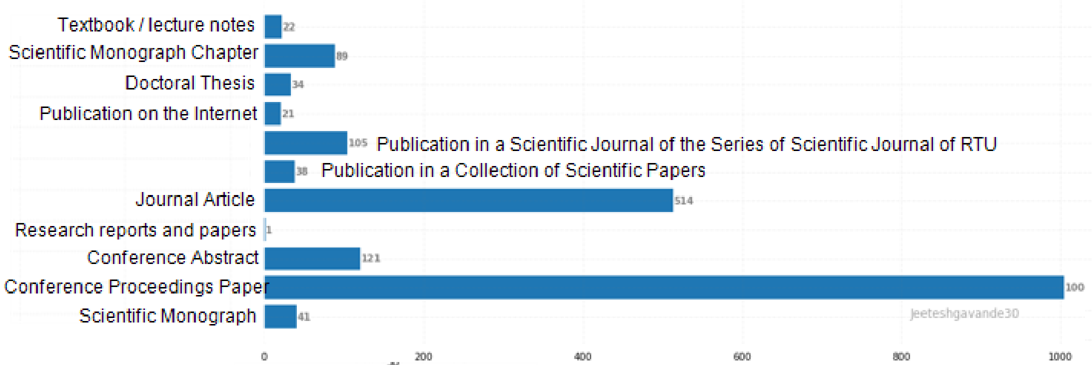
Number of publications in the study field for the period 2013 - 2021



Source: RTU Publications Database 2022
Riga Technical University

Despite COVID-19 imposed restrictions and the consequent drop in scientific activity, a gradual increase of the scope of scientific results could also be observed in 2020 and 2021. In general, the results of academic work are published not only in the scientific publications but also in other publications depending on the nature of the research results in question. The breakdown of the number of publications by the different editions is given below.

Type of publication
Number of publications in the study field for the period 2013-201



Source: RTU Publications Database 2022
Riga Technical University

It is important to point out that the notable majority of the publications are reports on the results of scientific research published in various types of scientific publications. In line with the specifics of the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", the majority of publications were published in the proceedings to the conferences where academic staff participated with their presentations. The summarized data show that academic staff have participated in the conferences with the reports **more than 1,000 times**.

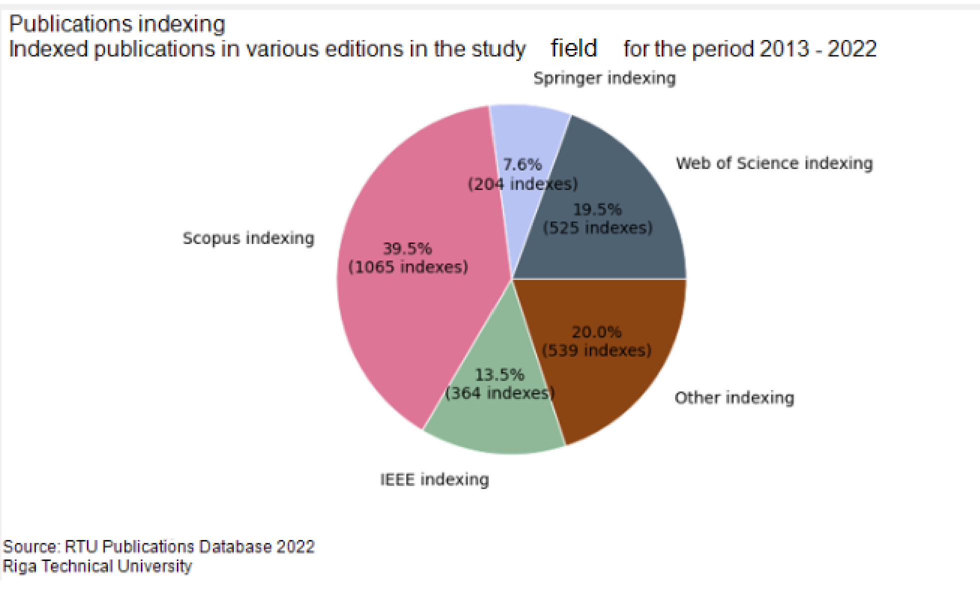
The study field is currently undergoing very rapid development. It requires publication of the research results obtained as soon as possible. For these reasons, most publications are published directly in the conference proceedings. Scientific journals are the next largest platform for scientific discussion, and their significance is growing in line with RTU Strategy guidelines for achieving research excellent goals.

Academic staff of the study field are relatively active in publishing the results of scientific research in scientific monographs and the chapters of scientific monographs, as well as in other collections of scientific publications, which, in addition to the abovementioned platforms, allows focusing attention on specific results, thus promoting international scientific contribution of the academic staff.

In order to promote engagement of young scientists in the current research field, a significant number of publications is published in scientific journals of RTU, the main results of the PhD Theses are also published. In addition, the publication of the main results of the Master and Bachelor papers in the books of abstracts is also promoted, thus facilitating scientific discussion among students and promoting their interest in the post-graduate education.

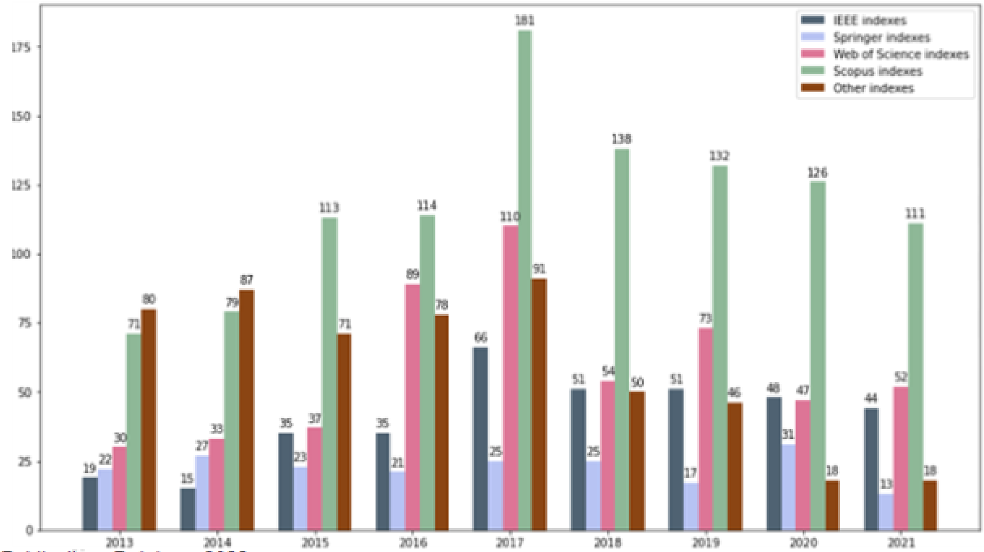
In the reporting period, 22 textbooks and various other publications were published, contributing to the promotion of the study field and facilitating its development by updating the learning aids.

In line with the RTU Strategy, in order to improve scientific performance, more attention has been paid to improving citation and indexing indicators, which allowed reaching **~2500 indexes** in the databases and **~2000 citations** in the reporting period. The breakdown of indices by publications is given below:



As it can be observed considering the breakdown of indices, most citations are recorded in the internationally recognized databases of scientific collections, including IEEE, Scopus and WoS, which are used to assess the quality and results of scientific activity in general.

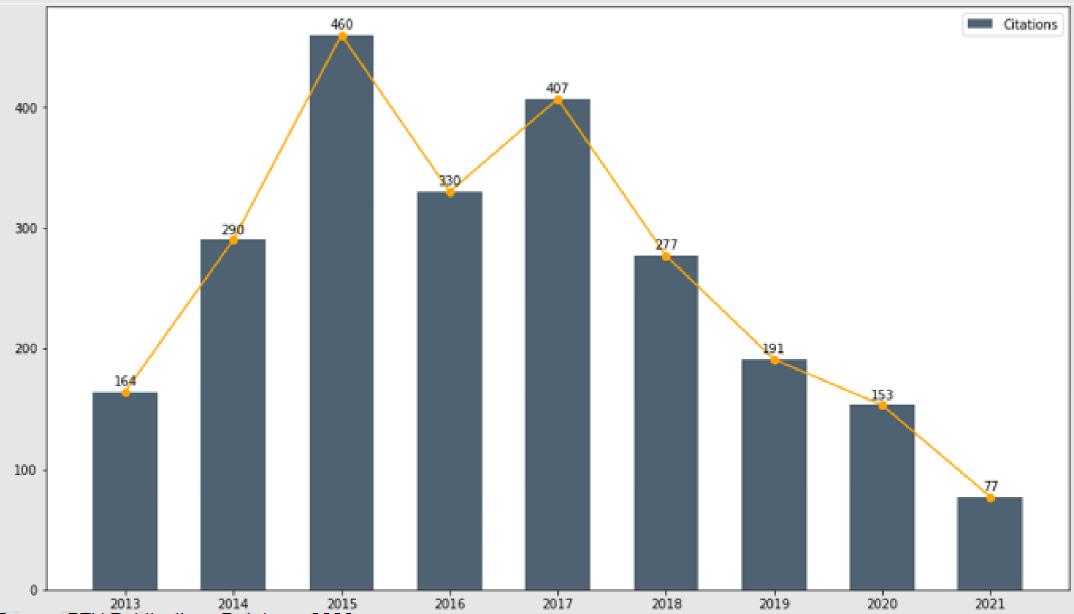
Publications indexes
Publications indexes in various data bases in the study field for the period 2013 - 2022



Source: RTU Publications Database 2022
Riga Technical University

The indexation numbers and their dynamics in different editions demonstrate the overall positive trend – the growth of indexing in the internationally recognized databases vs. lesser-known ones. This trend also persisted during the COVID-19 imposed restriction period, which attests that the scope of scientific activity has been maintained. The dynamics of the number of citations also demonstrate a strategic change in the RTU policy – targeted support to publishing in the highly cited publications, which was not so pronounced at the beginning of the reporting period.

Citation of publications
Number of citations of publications in the study field for the period 2013 - 2022



Source: RTU Publications Database 2022
Riga Technical university

At the end of the reporting period, the number of citations has decreased, which may be attributed to the inertia of the growing trend in the number of citations, which usually lasts for 3-5 years when the highest relative number of citations per year is reached. Thus, a targeted policy change at the beginning of the period has allowed reaching the maximum citation index of the published reports within 3-5 years (2015-2017). At the same time, publications published in 2020 or 2021 have not yet reached their peak.

Researchers working in the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” actively participate in various activities promoting science and cooperation, also by organizing them. Examples of the implemented measures are given below:

- “**Research Platform Breakfast**” is organized annually. Representatives of various organizations are invited to participate in the event, which provides a platform for presenting the results of research activities. In 2022, the FCSIT organized this event in the field of military research, and cooperation of RTU researchers with the Latvian National Armed Forces was discussed, the main research achievements were presented, and possible future studies were considered.
- Annual **Robotics competitions** is organized by FET, FCSIT and LETERA with the aim to attract young people of school age to engineering, as well as to provide support to Latvian technical innovation organizations and groups. The competition has been held since 2008.
- In 2021, a **Hackathon of Military Developments** was organized, which allowed developing and testing several perspective ideas of technical solutions in order to further develop them in the form of specific projects. The projects were presented to representatives of the Latvian NAF and the MoD, who welcomed the results achieved.
- FET regularly supports **Latvian Electronics Days**, which are organized together with LETERA, to attract young people of school age to the field of electronics and to support technical innovation organizations and interest groups.
- Representatives of Riga Business School participate in **Junior Achievement** student business ideas development competition and fair, which supports the development of student product ideas characteristic of the study field and also untypical for it in the development of student product ideas and in a public exhibition.

Less significant events aimed at promoting scientific results and attracting new researchers or expanding cooperation are also regularly organized.

Information on the publications of academic staff, participation in the conferences, artistic activities, participation in the projects, and patents is summarized in the relevant annexes.

2.4.5. Specify how the involvement of the students in scientific research and/ or applied research and/or artistic creation activities is promoted. Provide the assessment and description of the involvement of the students of all-level study programmes in the relevant study field in scientific research and/ or applied research and/or artistic creation activities by giving examples of the opportunities offered to and used by the students.

RTU maintains mechanisms for involvement of students within all education cycles and study programmes in research. Various activities are implemented aimed at enhancing the PhD studies and ensuring career opportunities for young researchers in post-doc period.

Doctoral grants are provided to PhD students on a competitive basis. International calls are made to attract to post-doctoral projects. In addition, the internal Research Excellence Grant for young scientists was established in 2018 as a new initiative, providing 270,000 EUR for a 3-year period based on the international competition (conditions are similar to EC ERC grant with international call and evaluation performed by external, i.e., foreign well-recognized researchers). The grant allows young and talented researchers to establish their own research groups and build a research career at RTU. Internal project calls provide additional funding for publishing articles in SCOPUS/WoS indexed editions, and internal projects within 6 research platforms stimulate involvement of PhD and Master students in multi-disciplinary and inter-faculty research projects in cooperation with the industry. The Research Support Fund (10% of the research base funding is allocated to this fund) provides support to PhD students (attending conferences, publishing papers and the PhD thesis, etc.). Employment of PhD students and post-doctoral researchers at RTU went up from 0 FTE in the period of 2013-2016 to 88 FTE (PhD students) and 97 FTE (Post-doctoral researchers) in 2018. 17 post-doctoral 3-year projects with total funding of 2.28 million EUR were launched in 2017. The funding covers salaries, costs of materials and mobility, as well as support for further development of research skills (circa 134,000 EUR are allocated to one project). 16 post-doctoral 3-year projects were launched in 2018 and 12 post-doctoral 3-year projects were launched in 2019 with total funding of 3.7 million EUR. 18 post-doctoral 3-year projects with a total funding of 2.4 million EUR were launched in 2020. In 2021, at least 10 projects should be launched. The post-doctoral projects allow attracting new researchers to RTU from foreign and other Latvian research institutions, and providing academic career opportunities to PhD students who graduate from RTU.

Internal project calls within the six research platforms, which are organized every year, have criteria regarding the involvement of students in the project, giving an additional score if students at the Bachelor, Master or PhD level are involved in the project.

The Design Factory (DF) of RTU (see additional information about the DF below) organizes the study course “Vertically Integrated Project” (VIP), during which interdisciplinary student teams develop a challenging long-term research project under the guidance of experienced researchers. The course is implemented in cooperation with researchers from the Georgia Institute of Technology (the USA). Within the course, cross-disciplinary student teams are assembled, bringing together students from at least three different study programmes, and ranging from first-year Bachelor students to PhD students, as well as involving pupils from the Engineering High School (EHS) of RTU (see additional information about the EHS below). During the course, students participate in research work under supervision of RTU researchers, working together with students of other study programmes and gaining experience in research as well as in team and project work. At the end of the course, each team presents its progress and demonstrates the results obtained. For example, during spring semester of 2019, the call for VIP courses was announced for three topics:

- sensor systems and networks (group leader Prof. Jurģis Poriņš);
- wastewater treatment (group leader Prof. Tālis Juhna);
- energy efficient houses (group leader Leading Researcher Jānis Zaķis).

The course is registered as a free elective study course and two credit points are assigned to the student in the semester.

The Engineering High School of Riga Technical University is the first general secondary education establishment in Latvia that has been founded within the framework of a university. It is the place where the most talented Latvian pupils can acquire the study courses in exact and natural sciences at an advanced level to get prepared for the engineering studies. At the EHS, special attention is paid to the integration of engineering studies and scientific research activities into the study process.

The establishment of DF Labs (http://rtudf.rtu.lv) for design and prototyping is a success story. Idea of having the Lab at RTU was inspired by a positive example of Aalto University in Finland. Its task is to provide expertise and shared infrastructure for developing prototypes of new products and technologies, based on ideas of students and researchers. RTU DF also works with industry, start-ups and spin-offs and has established a very good reputation. We could observe that it considerably improved the involvement of students at all study levels in research and innovation activities and promoted cooperation of RTU with the industry.

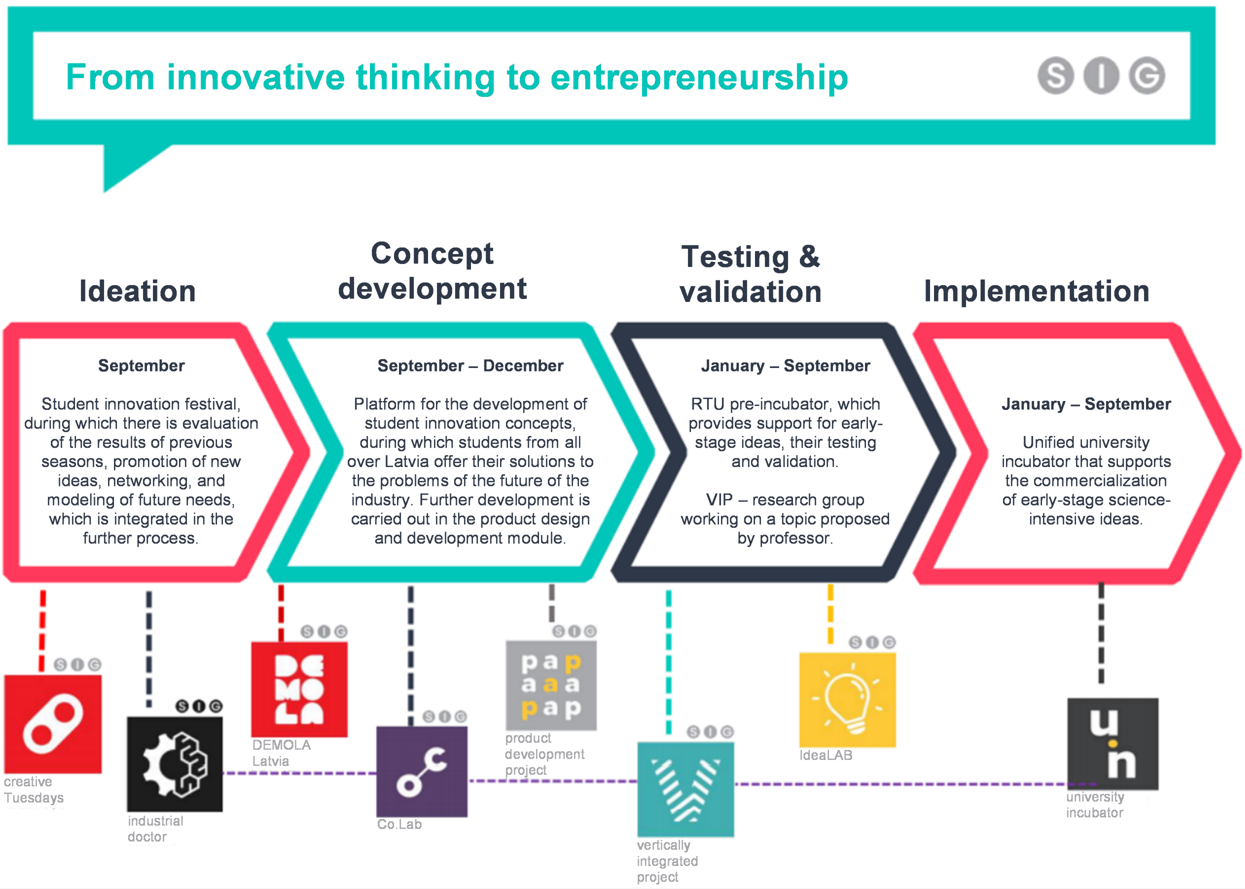
In order to develop students' innovative thinking, creativity and entrepreneurial skills, RTU implements the project "Innovation Grants for Students" (ERDF co-financed project No. 1.1.1.3/18/A/001 "RTU Innovation Grants for Students", the project finished on 30 April 2022). Students of all levels are offered to engage in various activities and improve their entrepreneurial skills, cooperate with the industry, develop early knowledge-intensive business ideas, receive a scholarships and support grants. "RTU Innovation Grants for Students" is a platform for students, industry and scientists that promotes mutual cooperation, development and creativity (see Figure The process of developing innovative thinking based on entrepreneurial skills).

Eight activities are implemented in the programme "RTU Innovation Grants for Students":

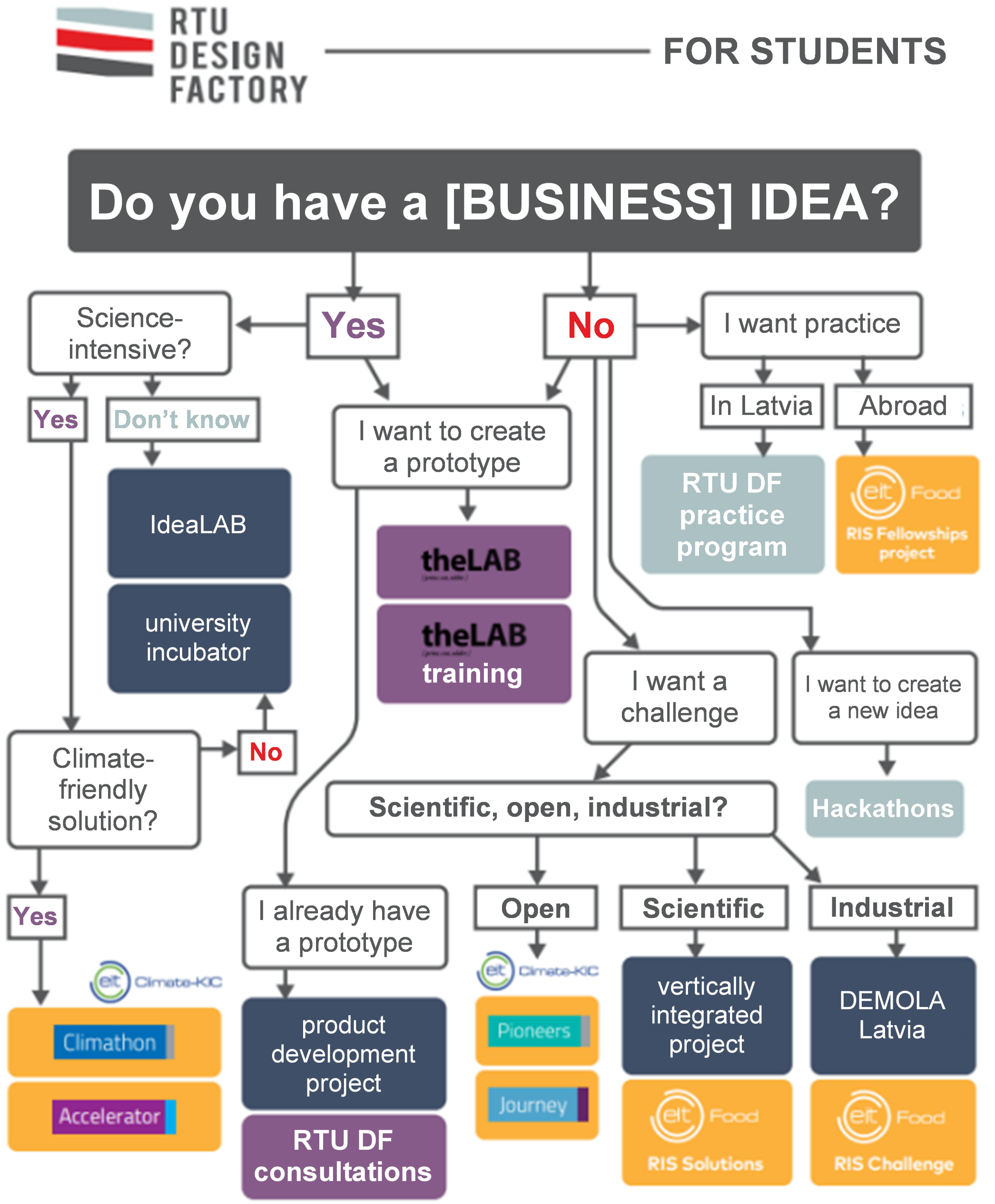
- **DEMOLA Latvia** – by bringing together students, academic and scientific staff from different universities and industry, innovative solutions concepts for ideas/issues defined by companies are being developed. To solve problems, interdisciplinary and intercultural student teams are created, involving young specialists of various fields, in order to develop their ability to cooperate with industry representatives already during their studies. The search for new solutions promotes design thinking, provides intercultural experience and understanding of the development of the industry and the development and implementation of new concepts. The cooperation platform DEMOLA Latvia is implemented according to the successful international open innovation cooperation platform DEMOLA Network.
- **Ideation measures** promote generation of new business ideas, team building, networking and the development of new products. The process is based on the generation of ideas, the development of a quick (time and space restriction conditions) solution and the receipt of expert evaluation. For example, hackathon, which lasts 24–48 hours, aims to create new teams and create new technological solutions. Initially, everyone who has a business idea presents it to the other participants. The participants then choose which idea to work on for the next 48 hours and build a real prototype of the product from scratch. The hackathon is a meeting place for representatives of different levels and professions.
- **Product development project (PDP)** – a training module in which student teams, systematizing and deepening their knowledge in the development of new products, technology transfer, commercialization of innovations and their results, create prototypes. The aim of the activity is to develop students' competence in the development of new products and technology transfer, to increase entrepreneurial skills and apply it in practice, while promoting the development of general creativity and planning skills, as well as to develop an understanding of modern business models.
- **Vertically integrated project (VIP)** unites students from different fields, allowing them to develop a large-scale design and research project, while strengthening and expanding the scientific activities of the academic staff. The aim of the activity is to create an opportunity for students from different study programmes and cycles to cooperate within a long-term research project – Master students and PhD students supervise design and research projects of the Bachelor students, which may be considered part of the research work of a Master or PhD student.
- **RTU IDEALAB** - pre-incubator provides support for new or existing business ideas of RTU students, facilitating the commencement of new business activities, providing support for the development and initial testing of a business idea. Both one student and a team where at least one representative is studying at RTU can apply for their ideas in the pre-incubation laboratory. RTU IdeaLAB is implemented at two levels. First of all, training takes place, which is aimed at validating and testing the idea, improving teamwork, identifying the common goal.
- **COMMERCIALIZATION TRAINING FOR SCIENTISTS LAB** – The aim of this activity is to develop and promote closer cooperation between the research and commercial sectors by

involving business leaders in the research of young scientists – PhD students, in parallel ensuring the evaluation of the commercial nature of the research and the promotion of the entrepreneurial capacity and innovative thinking of the young scientist.

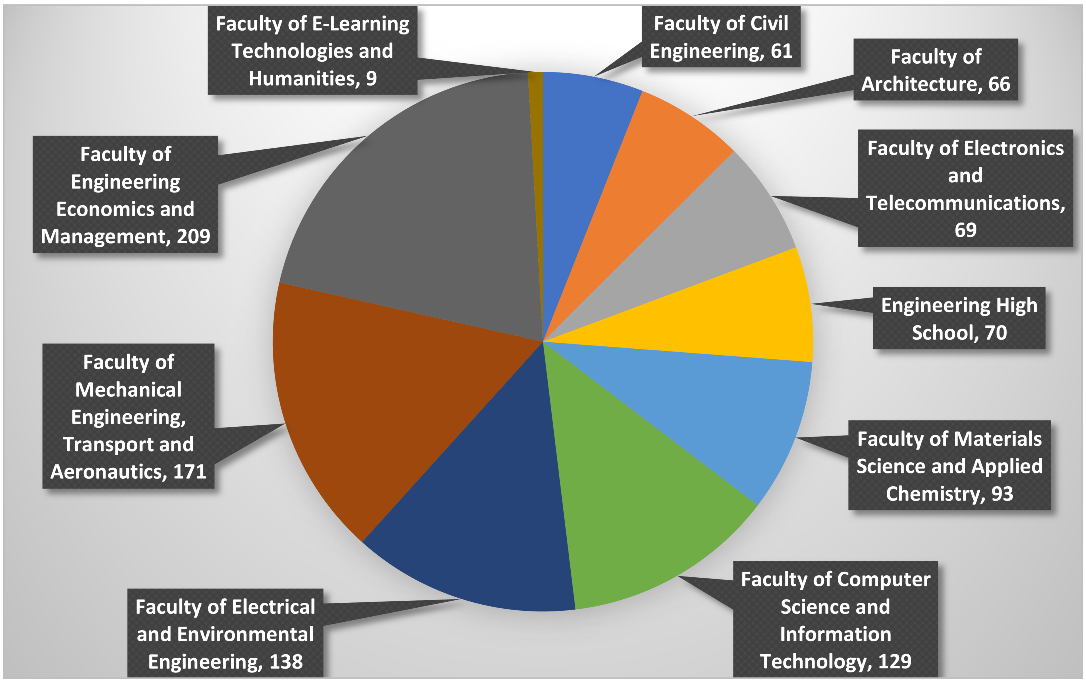
- **INDUSTRIAL DOCTOR** – development of the research within the PhD Thesis, taking into account the interests and needs of the company. Educating and training PhD students, the acquisition of the scientific method is usually based on the guidelines of problems created in the academic environment, as a result of which there is no pronounced link with the industry and its needs. The aim of this activity is to provide financial support to young scientists who are developing a PhD thesis on a topic useful for the development of the company and whose scientific development is necessary for the development of the respective company. The university in cooperation with the company educates and trains a PhD holder in the thematic area initiated by the company. The PhD student works at the university, but is actively involved in the company's R&D activities. The chosen theme is based on the university's scientific excellence and the company's strategic vision in technological development.
- **University incubator** aims to promote the development of research intense business ideas and the establishment of new high-value-added companies. Student teams are provided with support for the development and initial testing of a research intense business idea, preparing them for the next phase of development of ideas – attraction of private or public investments. The incubator offers expert advice to the teams (feasibility studies of business ideas, drafting of a business plan, market research, organization of working groups, business ideas for technological expertise and formation of a team of developers), equipped workplaces, trainings, services of external experts, technological expertise and support financing for the development of a business idea.



In all study programmes, students are actively involved in the practical transfer of business ideas. RTU Design Factory has developed a complex of measures to support the development of student ideas, which can be seen below:



The success of the programme and its contribution to the study process can be characterized by a significant number of students involved (also outside RTU), as well as with a significant increase in the number of participants in 2021. In 2019, ~ 220 students were involved in the program, but in 2021 – 1015 students from RTU (1438 in total), which accounted for 76% of the total number of students involved in the program. Of these, students in the study field accounted for 21% or 207 students. Their representation is listed below:



Students established 119 teams, which received 515 scholarships for a total amount of ~ 326,000 EUR. Innovative ideas were purchased by 14 companies for a total amount of ~ 40,000 EUR.

The programme significantly promotes students' entrepreneurial, innovation implementation and innovation process management skills, which has allowed at least 10 teams to continue the process of attracting investment.

2.4.6. Provide a brief description and assessment of the forms of innovation (for instance, product, process, marketing, and organisational innovation) generally used in the higher education institution, especially in study field subject to the assessment, by giving the respective examples and assessing their impact on the study process.

Innovation, valorization and introduction of innovative methods in the study process is one of the strategic priorities of RTU. In order to promote the integration of students into innovation processes characteristic to the areas in the study field, study courses related to the development and commercialization of innovative products provided by FEEM academic staff have been introduced in all Bachelor study programmes implemented by RTU in all faculties. The course is rooted in the MIT *(Massachusetts Institute of Technology)* methodology for innovation, innovation development and continuous knowledge transfer. Within the framework of the study course, students practically working in projects develop entrepreneurial competence and creative thinking. Part of the project is performed at RTU Design Factory dealing with prototyping, turning students' theoretical knowledge into real products or services. As a result of the complete process, students understand whether they are scientists, inventors or whether they are engineers and entrepreneurs. Student learn how previously identified consumer needs can be converted into a product or service. It makes a significant contribution to the development of engineering students' skills and competences by promoting their integration into today's innovation and business ecosystems.

PhD study programmes have been updated during the reporting period, including skills for the identification, protection and commercialization of intellectual property objects. Taking into account the specifics of the study programmes, FCSIT has supplemented its academic staff with an experienced commercialization and investment raising specialist who transfers his experience and knowledge to the students, as well as performs the duties of the Deputy Dean in Valorization. In this way, the attraction of the comparatively limited experience in the conditions of Latvia to a particular study field is promoted.

The set of various activities has allowed to successfully attract funding to innovative and potentially commercialized projects. The most important of these are:

- Project No. KC-PI-2017/57 “Multi-robot systems for cleaning industrial premises” of the specific support objective 1.2.1 “To increase private sector investment in R&D” of the programme “Growth and Employment”, which has successfully ended with the auction of intellectual property. As a result of the auction, Ltd "Robotic Solutions" became the owner, which is currently successfully improving the technology and attracting investments for further business development.
- Within the framework of the programme “Mitigation of Covid-19 consequences” project No. VPP-COVID2020/1-0009 “Emerging technologies for durable and safe services” (ARTSS) created intellectual property “Vehicle arrival time forecasting algorithm”, which has been successfully commercialized through an appropriate intellectual property auction.
- Within the framework of the specific support objective 1.1.1 “To increase the research and innovative capacity of scientific institutions of Latvia and the ability to attract external financing by investing in human resources and infrastructure” of the programme “Growth and Employment”, an intellectual property object has been created within the framework of the project No. 1.1.1.1.1.1/16/A/072 “Passive fiber optical sensors for energy efficient monitoring of the technical condition of transport infrastructure”, which has been successfully commercialized by through the auction of the license.

RTU maintains the UseScience database, which is available to Latvian and foreign researchers and entrepreneurs including the joint use of equipment and facilities to promote innovation and cooperation with industry companies. This promotes cooperation and efficient use of infrastructure.

A database of commercialization offers is also maintained, which allows entrepreneurs to get acquainted with the ideas having commercialization potential which can be jointly developed, which promote the emergence and implementation of joint projects.

In addition, academic staff of the study field perform registration of intellectual property in Latvian and international patent registers. ~ 15 patents were registered during the reporting period, including patents of the EU Patent Register.

In order to promote the introduction of innovations into pedagogical practices of the study field and administrative management practices of organizational units, RTU in cooperation with the Ministry of Education and Science of the Republic of Latvia and the Ministry of Economics of the Republic of Latvia jointly implement projects of the Latvian digital agenda. The projects are aimed at raising the digital skills of higher education and the Latvian society, as well as at the introduction of digitalization-led management processes in the Latvian higher education institutions. Within the framework of the projects, the main activities are focused on the development of academic and administrative staff, taking on the experience of the USA and other countries. The main partners in the U.S. are the University at Buffalo and Massachusetts Institute of Technology. At least 20 academic and administrative staff have undergone training within the framework of the project (for a semester to two semesters). The employees who have completed the training are ready to share their experience and contribute to the development of the study field.

2.5. Cooperation and Internationalisation

2.5.1. Provide the assessment as to how the cooperation with different institutions from Latvia (higher education institutions/ colleges, employers, employers' organisations, municipalities, non-governmental organisations, scientific institutes, etc.) within the study field contributes to the achievement of the aims and learning outcomes of the study field. Specify the criteria by which the cooperation partners for the study field and the relevant study programmes are selected and how the cooperation is organised by describing the cooperation with employers. In addition, specify the mechanism for the attraction of the cooperation partners.

Cooperation with employers and professional organizations in the sector

The organizational units involved in the implementation of the study field – FCSIT, FET, FETH and RBS – are relatively active, establishing cooperation with external organizations and regularly expanding the range of cooperation partners. Every year, forms and content of cooperation are improved, both within the framework of academic and commercial cooperation.

The structural units involved in the implementation of the study direction maintain close cooperation with the associations and professional organizations of the corresponding sectors, which ensures a sustainable and intensive dialogue with industry companies and policymakers necessary for the development of the study direction. The choice of specific cooperation partners depends on the development activities of specific study programs; however, several factors are taken into account within the study direction to decide in favour of cooperation with a specific company. Including the company's activity and initiative in the activity of professional organizations, its contribution at the national level, influence on the development trends of the labour market, the ability to create exportable products specific to the sector, and contribution to the development of scientific research in the relevant sector, as well as other less important factors. Similar factors are essential for the organization of cooperation with foreign companies that have established their branches in Latvia, thereby participating in the development of the Latvian labour market and the development of the industry as a whole.

The main forms and activities of cooperation are:

- Supervision and review of study and graduation paper, which includes offering the themes of graduation and study papers, scientific supervision, as well as involvement of reviewers and participation in the Viva Voce Examination Committees of graduation papers.
- Provision of internships, which includes the offer and management of internships. The offer of the internship also includes the involvement of an expert in the field – an internship supervisor, who within the framework of daily work ensures the provision of work tasks to the trainee, training and assessment of the performed tasks.
- Cooperation in ensuring the quality of implementation of the study programmes in the study field, which includes participation in the Study Field Committee, Advisory Board of the faculties, as well as cooperation within various non-governmental organizations, for example, within the framework of sectoral associations.
- Joint research within the framework of scientific or commercial cooperation, which allows to jointly attract funding for the performance of important research for the sector and the implementation of the obtained results.
- Implementation of national and public development projects, which also include foreign

academic institutions, for example, joint implementation of Latvia's digital agenda and economic reconstruction projects.

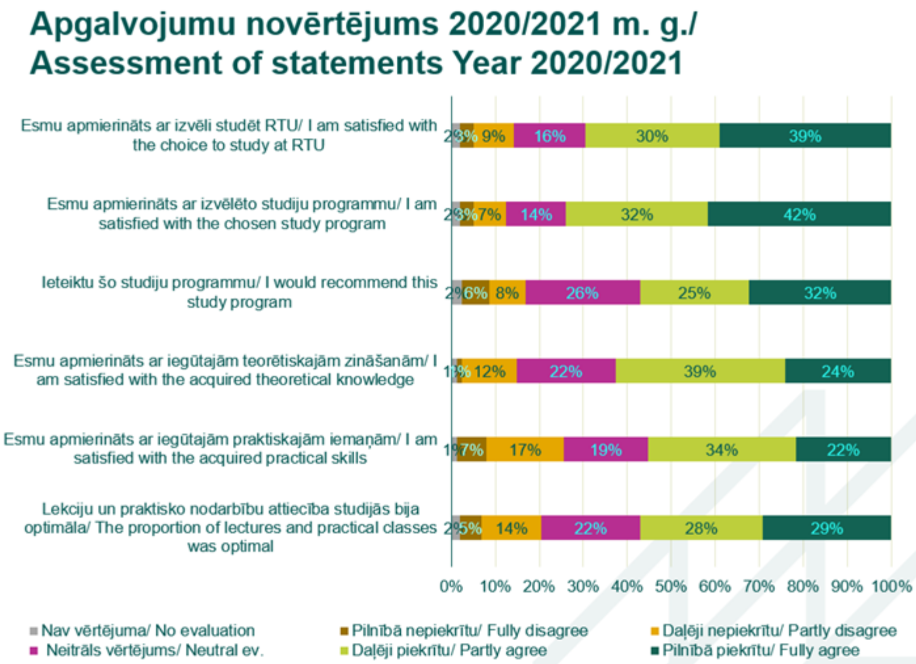
- Joint implementation of student support measures through the participation of industry in the role of sponsors.
- Joint events and their organization also in RTU premises, which allows maintaining an active dialogue directly with industry representatives and graduates of the study field, who successfully work in various industry organizations.
- Student study trips to the leading industry companies, promoting better understanding of the working environment and the tasks to be solved in practice.
- Improvement of study curriculum with inclusion of sector-specific knowledge blocks in the study process, as well as joint implementation of studies in the fields of skills and knowledge topical for the sector.

The mentioned forms of cooperation and the industry organizations involved in the cooperation allow to actively participate in the processes of national digital transformation, thus directly contributing to the achievement of the main goal of the Study field - to be a leader in the processes of digital transformation. Cooperation on a practical level is carried out in specific development, research or commercialization projects, as well as in the framework of various policy-making and public initiatives, for example, within the framework of the IZM SAM programmes, within the framework of LIAA commercialization projects, in the programmes of the LR EM Competence Centers (both in projects and in the activities of creating centers), IZM in the implementation of international initiatives for cooperation with US and European universities and policy-making organizations, as well as within the framework of other initiatives. This has allowed the Study field to become the leader within the aforementioned initiatives in Latvia and thus bring the achievement of the set goals closer.

In order to ensure the availability of up-to-date and reliable information to the heads of the study programmes, surveys of both graduates (new employees of the field) and employers on the curriculum, study forms and the need for their improvement are carried out on a regular basis. Employer survey data show that companies take interest in various types of cooperation, such as providing internships for students (the most common answer), participating in scientific projects, participating in the improvement of the content of the programmes, organizing study trips, etc.

At the professional programmes, cooperation with employers takes place in the form of **mandatory** internship, namely, an internship supervisor – a representative of the company – provides feedback on the student's skills, knowledge, work culture and other issues important for the implementation of the internship, which allows evaluating the course of the internship and achievement of the learning outcomes. Each year, the university enters into cooperation agreements with companies and organizations (see Annex 37 to the List of Internal Regulatory Enactments for the template of the contract), where it is agreed on the provision of internship places for students, thus ensuring not only the place of internship, but also specific requirements for those who support the achievement of the objectives of the relevant study programmes.

Graduate surveys indicate (see below) that cooperation with the industry ensures the provision of expected knowledge and practical skills to the students.



On 26 June 2017, a new Advisory Board of RTU was established. The aim of the Advisory Board is to promote the development of RTU in line with the RTU Strategy and the needs of the national economy. The main tasks of the Advisory Board are to advise and provide opinions to RTU Senate and Rector on the issues related to RTU development strategy. The study field in the RTU Advisory Board is represented by 5 advisers out of 23, which allows promoting the development of RTU also in the issues important for the study field. It is important that the study field is represented by the leading employees of such ICT companies as Ltd LMT, Ltd Accenture Latvia and JSC SAF Tehnika. In addition to the cooperation of an advisory nature, academic staff of the study field is active in cooperation with various non-governmental organizations. The main cooperation organizations are:

- Latvian IT Cluster unites Latvian exporting ICT companies. RTU is a member of the organization. (https://www.itbaltic.com/) Latvian Electrical Engineering and Electronics Industry Association (LETERA) unites Latvian electronics and electrical engineering companies and research institutions. RTU representative included in the Board of LETERA. (https://www.letera.lv/)
- Latvian Information and Communication Technology Association (LIKTA) unites industry companies and research institutions. RTU representative is the member of the Board of LIKTA. (LIKTA - IKT/IT Asociācija, Latvija. Telekomunikācijas un Izglītība)
- Latvian Open Technology Association (LOTA) unites organizations and private individuals, including information technology suppliers and users, who seek for economic benefits for themselves, their organization or society as a whole from the wider use of open technologies in Latvia. RTU representative works on the board of the organization. (https://www.lata.org.lv/)
- IT Competence Centre (ITCC) unites leading research institutions and companies in the field. RTU is one of the founders of the Competence Centre. (IT kompetences centrs (itkc.lv))
- Latvian Electric and Optical Equipment Industry Competence Centre (LEO CC) unites leading research institutions and companies in the field. RTU is one of the founders of the Competence Centre. (LEO (leopc.lv))

In order to promote innovation, business growth and business sustainability, LIAA in cooperation with RBS has launched business training for entrepreneurs (Mini MBA) since September 2018. The aim of this training is to highlight the importance of innovation in organizations by providing participants with practical experience in developing new products and services. The training is organized within the framework of the LIAA project “Innovation Motivation Program” and is co-financed by the European Regional Development Fund and the European Union.

During the reporting period, an infrastructure development project has been implemented with the attraction of support from enterprises in the sector, which has allowed to fully equip the recreation and work station for the students in the public premises of the FCSIT faculty – corridors and recreation niches. Within the framework of the project, 70KEUR were attracted, which allowed to purchase furniture and work station equipment, as well as ensure training hours using a modern virtualization solution in the amount of 10KEUR.

To ensure the compliance of the study content, successful cooperation with Ltd TestDevLab has been established, which has allowed launching the study courses “Testing and Software Quality”, “Automated Functional and Load Testing of Web Solutions” and “Continuous Automation of Software Server Tests”. The above-mentioned courses complement the introductory level courses on software testing, thus providing students with the opportunity to specialize in testing engineering, an area that is relatively poorly developed in Latvia in academic education. During the cooperation, learning aids were developed in accordance with the current good practice, training of the educators was carried out at the company Ltd TestDevLab.

Cooperation with the universities in Latvia

Cooperation with higher education institutions in other countries and other fields in Latvia mainly serves as a source for diversifying the study content, improving pedagogical methods, as well as enriching scientific thought. In accordance with the strategic guidelines of the study field and RTU, the faculties implementing the field have set becoming the leading centers of pedagogical and scientific thought in their fields with at least regional contribution as one of their main tasks. To achieve this, cooperation with Latvian and foreign institutions is directed towards the achievement of the following aims:

- internationalization of scientific and pedagogical activities;
- development of students’ international experience, paying special attention to the areas that are not sufficiently developed at RTU;
- attraction of international students and academic staff with the aim of improving study and scientific activity processes, as well as establishing long-term cooperation with foreign organizations;
- improvement of the study content in the areas characteristic of the field and, in particular, not characteristic of the field, with the aim of improving the interdisciplinary fields of study.

In addition to the above, research cooperation with companies and research organizations of various fields is also implemented within the study field. Among the most important cooperation agreements for the study field are the following:

- Cooperation agreement No. 01/2012 Ltd “Air Studio” - Cooperation in the field of research and innovation in unmanned flight equipment and its control equipment.
- “ARC Informatique” (France) - Cooperation in joint research and projects.
- RISE Swedish Research Institute – Post-doc research capacity increase (networking mission/ collaborative research/ training/ mobility) in the implementation of the research application.
- Eindhoven University of Technology (TU/e), Photonic Integration Technology Centre – Post-doc research capacity building (networking, development and discussion of scientific results, summer schools, study courses, professional qualification development, working groups, interviews, consultations, etc.) using remote tools and work forms.
- LATVIJAS MOBILAIS TELEFONS Ltd - The University in cooperation with the company educates and trains PhD holders in the themes initiated by the company. A PhD student works at the University, but is actively involved in the company’s R&D activities.

- EVENTECH Ltd - Agreement on the transfer of measuring equipment, tools, computer equipment for free of charge use.
- Ubiquiti Networks (Latvia) Ltd on the use of resources. Attracting students and scientific staff to testing and problem analysis.
- Sintegra Ltd - For ensuring the internship of academic staff in the project “Strengthening academic staff of Riga Technical University in the fields of strategic specialization”.

The details of the contracts are given in the relevant annexes to the report. Agreements have also been concluded between RTU, UL and LUA on the possibilities of continuing studies in case of unforeseen circumstances in various study programmes in the study field.

The “Industrial Doctor” programme has been implemented since 2020. The aim of this activity is to provide financial support to young scientists who are developing a PhD thesis on a topic useful for the development of the company, and whose scientific development is necessary for the development of the respective company. The chosen topic is based on the research excellence of the university and the strategic vision of the company in the development of technologies. Within the framework of the study field, two industrial PhD studies are being implemented in cooperation with Ltd LMT. It promotes the implementation of the company’s innovation projects and allows achieving research results important for the national economy at RTU.

A summary of cooperation agreements with various Latvian and foreign institutions is given in the relevant annex. It should be emphasized that the number of cooperation agreements, as well as the terms of operation specified in the agreements, are variable, that is, both new agreements are concluded every year, as well the already concluded cooperation agreements are continued.

2.5.2. Provide the assessment as to how the cooperation with different institutions from abroad (higher education institutions/ colleges, employers, employers’ organisations, municipalities, non-governmental organisations, scientific institutes, etc.) within the study field contributes to the achievement of the aims and learning outcomes of the study field. Specify the criteria by which the cooperation partners suitable for the study field and the relevant study programmes are selected and how the cooperation is organised by describing the cooperation with employers. In addition, specify the mechanism for the attraction of the cooperation partners.

The choice of cooperation partners takes place based on the previous experience of the study field and cooperation of experts with foreign institutions in study, science, project development, participation in associations and other forms.

The organizational units involved in the implementation of the study field – FCSIT, FET, FETH and RBS – are relatively active in establishing cooperation with external international organizations. The range of cooperation partners is regularly expanded. Every year, the forms and content of cooperation are improved, within the framework of both academic and commercial cooperation.

The main activities of cooperation with local and foreign partners:

- Supervision and review of study and graduation paper, which includes offering the themes of graduation and study papers, scientific supervision, as well as involvement of reviewers and participation in the Viva Voce Examination Committees of graduation papers.
- Provision of internships, which includes the offer and management of internships. The offer of the internship also includes the involvement of an expert in the field – an internship

supervisor, who within the framework of daily work ensures the provision of work tasks to the trainee, training and assessment of the performed tasks.
- Joint research within the framework of scientific or commercial cooperation, which allows to jointly attract funding for the performance of important research for the sector and the implementation of the obtained results.
- Improvement of study curriculum with inclusion of sector-specific knowledge blocks in the study process, as well as joint implementation of studies in the fields of skills and knowledge topical for the sector.

In addition to consultative cooperation, academic staff of the study field is active in cooperation with various non-governmental organizations. The main international cooperation organizations:

- Institute of Electrical Engineering and Electronics (IEEE) – the largest international organization in terms of number of participants, which unites professionals and academic staff of the fields characteristic to the field of study (https://www.ieee.org/).
- Computational Technology Association (ACM) – brings together world computing and software development professionals and researchers (Association for Computing Machinery (acm.org)).
- The European Institute of Innovation and Technology (EIT) – brings together professionals and researchers from different fields to ensure sustainable innovation in the EU. Organization is established within Horizon Europe programme (https://eit.europa.eu/).
- European University of Technology (EUt) – unites technical universities of EU countries for the development of joint research and study programmes (Université de Technologie Européenne (univ-tech.eu)).
- Alliance of Digital Humanities Organizations (ADHO) unites the world associations and organizations in the field of digital humanities (https://adho.org/).
- European Association of Digital Humanities (EADH) unites European professionals and researchers in the field of digital humanities (including in data processing and digitalization, interdisciplinary research, archive/corpus management, etc.) (https://eadh.org/).

Since 2016, Riga Business School in cooperation with the American and Norwegian Chambers of Commerce organizes an annual RBS “Business Talent Forum” in Latvia uniting company representatives and students. The aim of the forum is to create a platform where government leaders, 120 corporate representatives meet with students and discuss the issues on the necessary skills, motivation and knowledge gained at universities to build a successful career or launch a business.

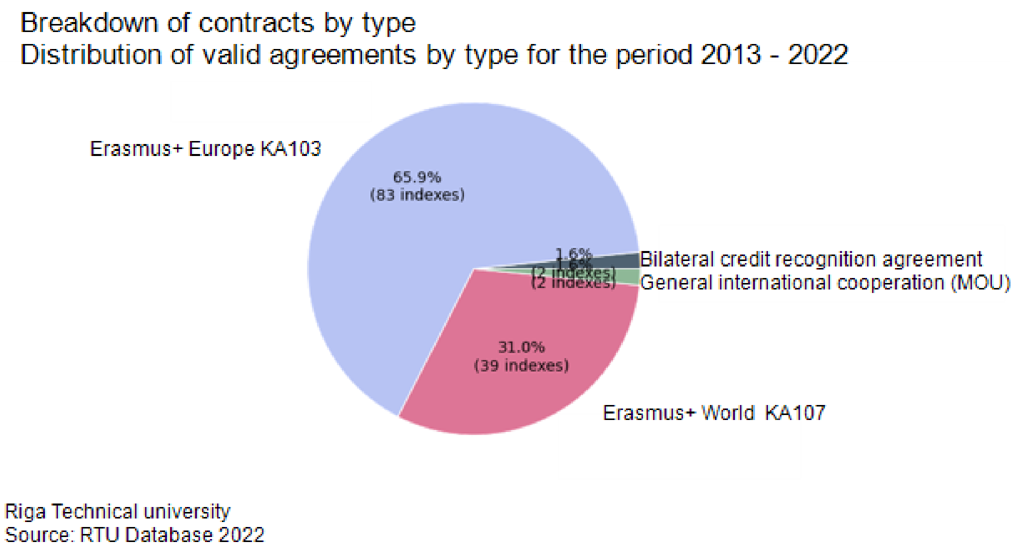
For ex.ample, in 2017 the theme of the event was “How to create an attractive, long-term company and how to develop, create future talents”. The forum was attended by representatives of such companies as Orkla Confectionery & Snacks, Gateway & Partners, iPS Media COO, Brain Games and Swedbank. As mentioned above, LIAA in cooperation with RBS since September 2018 started business training for entrepreneurs (Mini MBA). The training is organized within the framework of the LIAA project “Innovation Motivation Program” and is co-financed by the European Regional Development Fund and the European Union. It is important to stress that within the framework of the cooperation, the programme has been extended to include MIT (Massachusetts Institute of Technology) study courses, which allows offering study content, methods and technical solutions for the provision of the study courses.

Cooperation with the universities abroad

Cooperation with higher education institutions in other countries and other fields in Latvia mainly serves as a source for diversifying the study content, improving pedagogical methods, as well as enriching scientific thought. In accordance with the strategic guidelines of the study field and RTU, the faculties implementing the study field have set becoming the leading centers of pedagogical and scientific thought in their fields at least with regional impact as one of their main tasks. In this regard, cooperation with foreign institutions is directed towards the achievement of the following objectives:

- Internationalization of scientific and pedagogical activities;
- Development of students' international experience, paying special attention to the areas that are not sufficiently developed at RTU;
- Attraction of international students and academic staff with the aim of improving study and scientific activity processes, as well as establishing long-term cooperation with foreign organizations;
- Improvement of the study content in the fields characteristic of the study field and, in particular, not characteristic of the study field, with the aim of improving interdisciplinary study fields.

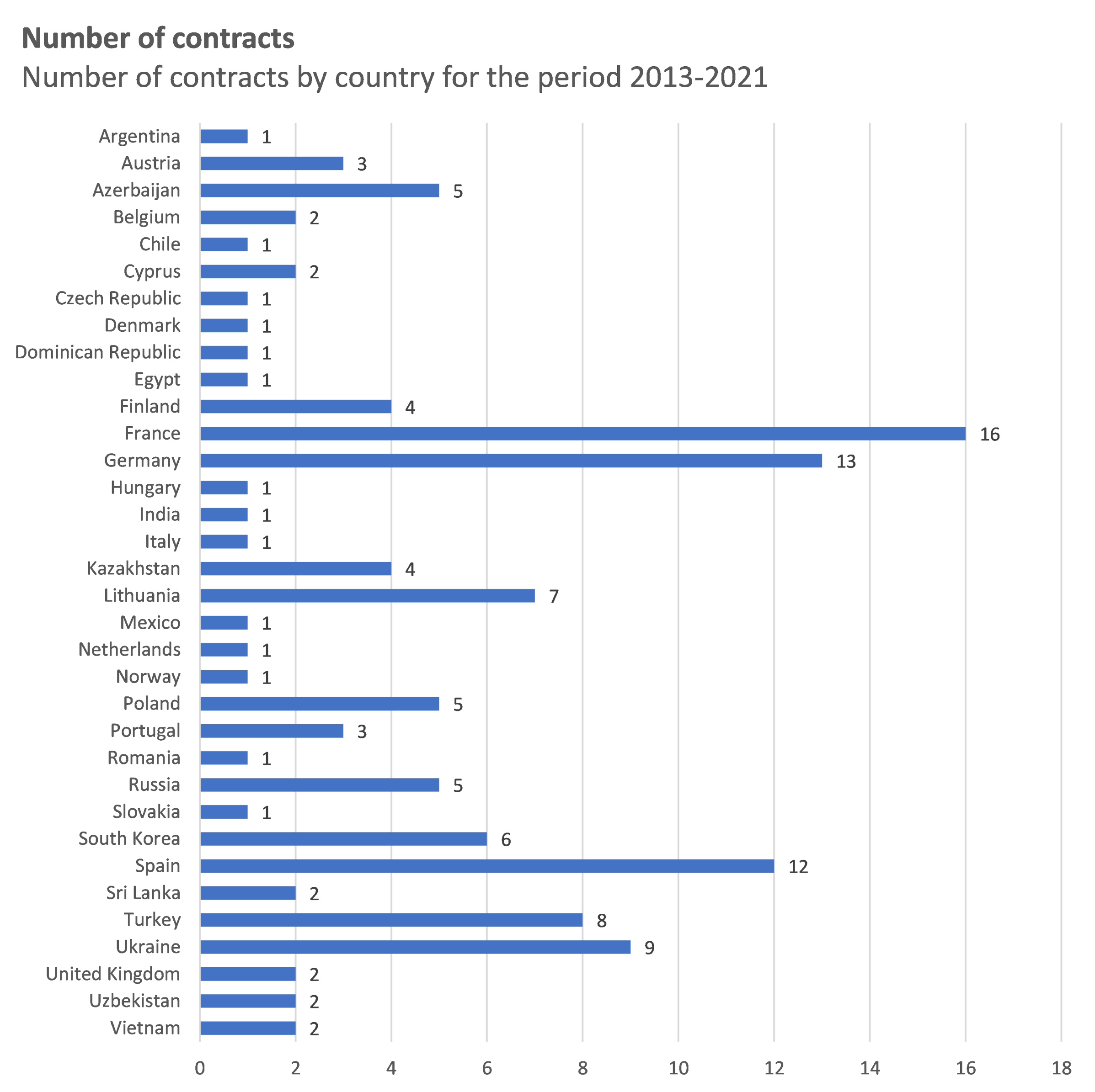
Signing of bilateral agreements is the most common form of academic cooperation implemented in order to achieve the set objectives:



As shown in the figure, most are Erasmus+ agreements, which allow for joint academic initiatives:

- development and implementation of joint study programmes;
- development and implementation of common MOOCs;
- exchange and enrichment of academic staff and students, as well as other mobility activities.

Within the framework of the study field, there is a total of 129 effective cooperation agreements, which also include mutual recognition of learning outcomes and other types of cooperation initiatives. The breakdown of the number of contracts by country is given below:



It can be observed that most contracts apply to the EU countries where Erasmus programme is implemented for a relatively long time, which allows obtaining the best experience available in these countries. In order for the cooperation to be successful and appropriate for the purposes of the study field, cooperation agreements are concluded with institutions which meet at least the following criteria:

- an internationally accredited and recognized higher education or research organization;
- academic and valorization activities are carried out in the fields related to the study field or related thereto;
- long-term and successful cooperation has been established within the framework of the Erasmus+ mobility programme for academic staff and students, especially in specific thematic areas, which allows for the establishment of interdisciplinary cooperation in the future;
- research or training infrastructure is available, which is not available at RTU for various reasons;
- prior research cooperation has been successful, which allows improving or expanding it also within the framework of other activities.

Within the framework of the study field, there is the BALTECH Consortium, which is a virtual association of higher education institutions of the Baltic Sea Region countries, which was established with the aim to strengthen closer and wider cooperation between universities in the Baltic Sea Region. This association brings together 6 universities of technology:

- Riga Technical University;
- Kaunas University of Technology;
- Linköping University;
- Tallinn University of Technology;
- Vilnius Gediminas Technical University;
- KTH Royal Institute of Technology.

The BALTECH Consortium is an essential forum for the exchange of information and the generation of ideas on what is happening in education, research and administration between Member States in the university region. One of the main tasks of the BALTECH Consortium is to ensure the mobility of students, administrative and academic staff; promoting joint research projects; to set up a consortium information network; to actively participate in the policy development in the fields of education and science in the Baltic Sea Region.

Since 1 September 2015, Riga Technical University has become the presiding university of the BALTECH Consortium, one of the priority tasks of which is to promote closer cooperation between technical universities of the Baltic and Nordic countries, thus making the Baltic Sea Region a research and innovation canter in the European Union. In 2019-2020, the BALTECH consortium was transformed into NORDTEK, which is associated with the accession of Baltic technology universities.

In June 2018, Riga Technical University organized the annual NORDTEK conference “Changes in globalization – challenges and opportunities for Nordic-Baltic higher education and research policy”. NORDTEK is a consortium of five Nordic technical universities (Sweden, Finland, Norway, Iceland and Denmark), whose members represent 27 universities, a total of more than 120,000 students, educators and scientists.

This conference also discussed the issue of integration of BALTECH participants (Riga Technical University, Vilnius Gediminas Technical University, Tallinn University of Technology, Kaunas University of Technology) into NORDTEK Consortium. Within the framework of the conference, on 7 June 2018, the meeting of NORDTEK Rectors approved an agreement on cooperation between NORDTEK and BALTECH technical universities in engineering education, which stipulated that:

- university students of associations can study at NORDTEK partner universities;
- students can take part in PhD courses at NORDTEK partner universities;
- educators can participate in delivery of the courses, development of the courses and their improvement at NORDTEK partner universities.

In September 2018, the Board of BALTECH Consortium decided that as of 1 January 2019, BALTECH is fully integrated into the Nordic NORDTEK network and, subject to a certain transitional period, BALTECH would cease its activities in 2020. Since September 2017, the University of Latvia and Riga Technical University, in cooperation with the University at Buffalo (USA), have launched a new cross-sectoral excellence program, which will be implemented by RTU Riga Business School (RBS). The studies will be conducted in English according to the world’s leading university standards coordinated by RBS.

The new programme will integrate IT competences with communication, project management, artistic, legal, financial and other skills that will lay the foundations for students to have a successful career in the digital age. The educators will have internationally leading academic and professional experience. Students with outstanding learning achievements can apply for financial sector scholarships.

Taking into account the strong state support for the implementation of this initiative, within the framework of the initiative additional training of Latvian academic staff (including the field of study) is implemented, which has been fully undergone by at least 60 lecturers, including more than 12 representatives of the academic staff of the study field. It is envisaged to continue and expand the initiative.

An agreement with MIT Media Lab has been concluded during the preparation of the report (https://www.media.mit.edu/) and HarvardX (https://vpal.harvard.edu/harvard-online-harvardx) on the transfer of study courses, pedagogical methods and technical means.

2.5.3. Specify the system or mechanisms, which are used to attract the students and the teaching staff from abroad. Provide the assessment of the incoming and outgoing mobility of the teaching staff in the reporting period, the mobility dynamics, and the issues which the higher education institution/ college faces with regard to the mobility of the teaching staff.

To attract foreign students to RTU, two communication target groups are mainly addressed:

- the internal: management team; general staff, academic staff; existing students;
- the external: prospective foreign students (foreign students studying in Latvia, foreign pupils and students, parents of foreign pupils and students); foreign graduates; mass media; opinion leaders; educational institutions; student recruitment education agencies; diplomatic and consular missions of the Republic of Latvia.

The communication strategy uses several types of information channels, choosing the most appropriate for each target audience – paid advertising channels, earned and owned ones. Marketing communication is an essential part of addressing foreign audience using all the traditional marketing tools – advertising in media and other channels, event marketing, direct marketing, digital marketing etc. The main marketing tool used to reach foreign audience is participation in various educational exhibitions and seminars organised by educational agencies in target markets. Continuity in the provision of information and promotion of studies is ensured by the long-term partner universities and educational agencies. In order to ensure a constant presence and provision of quality information about studies at RTU and student selection, RTU has opened its own information and study centers in specific countries.

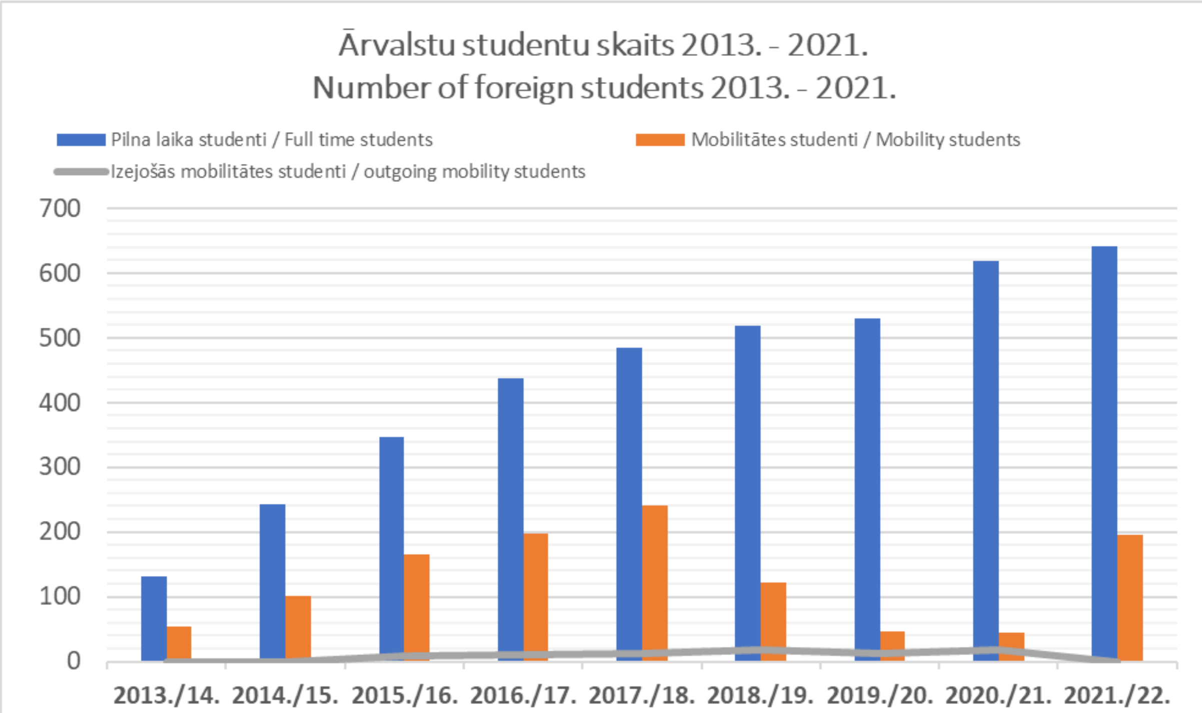
Various virtual seminars are widely used to address potential students, in which RTU ICFSD employees participate, existing students and employees delegated by the heads of the study programmes, who introduce prospective students to RTU infrastructure, study opportunities and requirements for foreigners, curriculum of the study program, future study opportunities, as well as career opportunities upon completion of the study programme.

ICFSD international student admissions staff help potential students in the issues related to the choice of admission and study programme using online counselling opportunities. Consultations are organized by prior appointment, every week, within a period of two months before the end of the enrolment period.

Potential students who have provided their contact information to RTU in connection with the commencement of studies, but have not submitted their applications for studies, are regularly repeatedly addressed at least once a month.

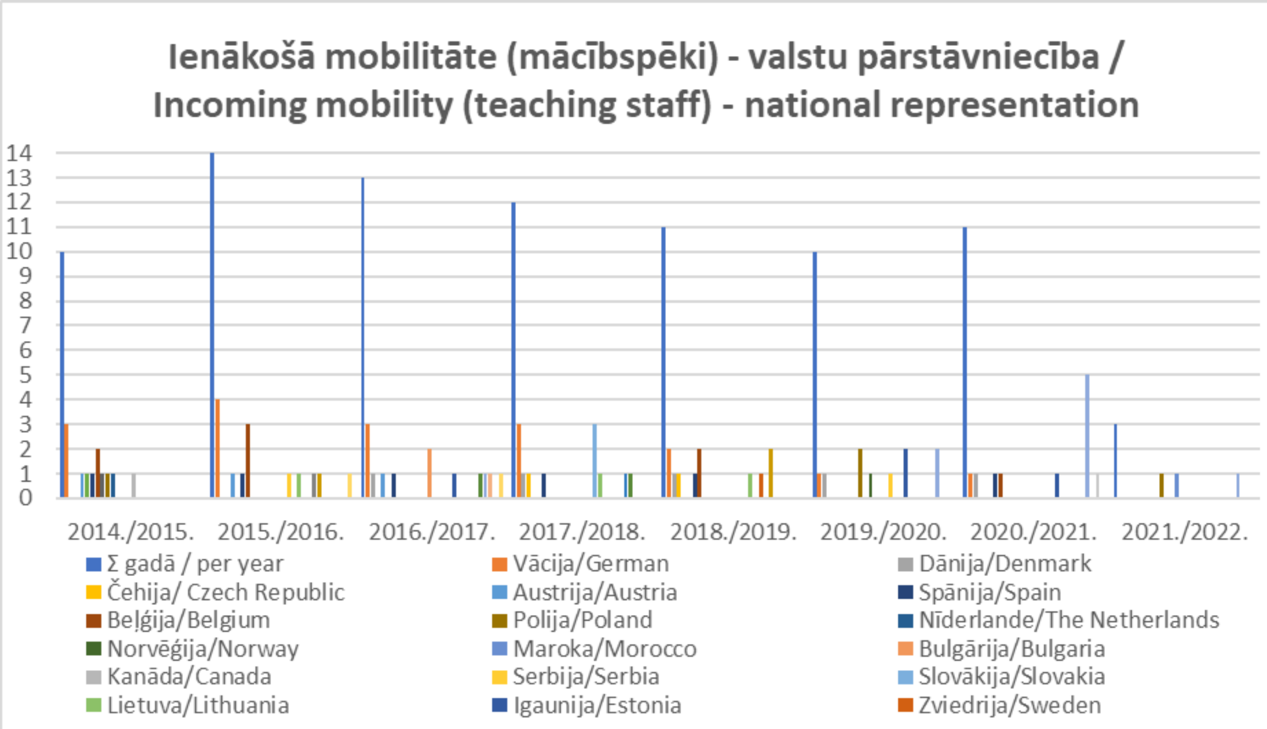
Public relations tools (press releases, media events, face-to-face meetings, interviews, opinion polls, etc.) and RTU social media channels (Facebook, WeChat, WhatsApp, Youtube, etc.) are used in corporate communication. RTU internal channels (ORTUS portal, email, etc.), information seminars and special events are used for internal communication.

RTU foreign student enrolment rates are summarized starting with academic year 2013/2014. The number includes only the students enrolled in the first year.



As it can be seen in the figure, the number of international students has a markedly increasing trend, which indicates the attractiveness of studies in the programmes implemented by the study field, as well as the relatively good efficiency of the existing mechanisms for attracting students.

A particularly rapid increase has been observed in recent years, when the policy of attracting students was changed, creating stricter selection mechanisms, which has allowed to strengthen the international reputation of the study field.

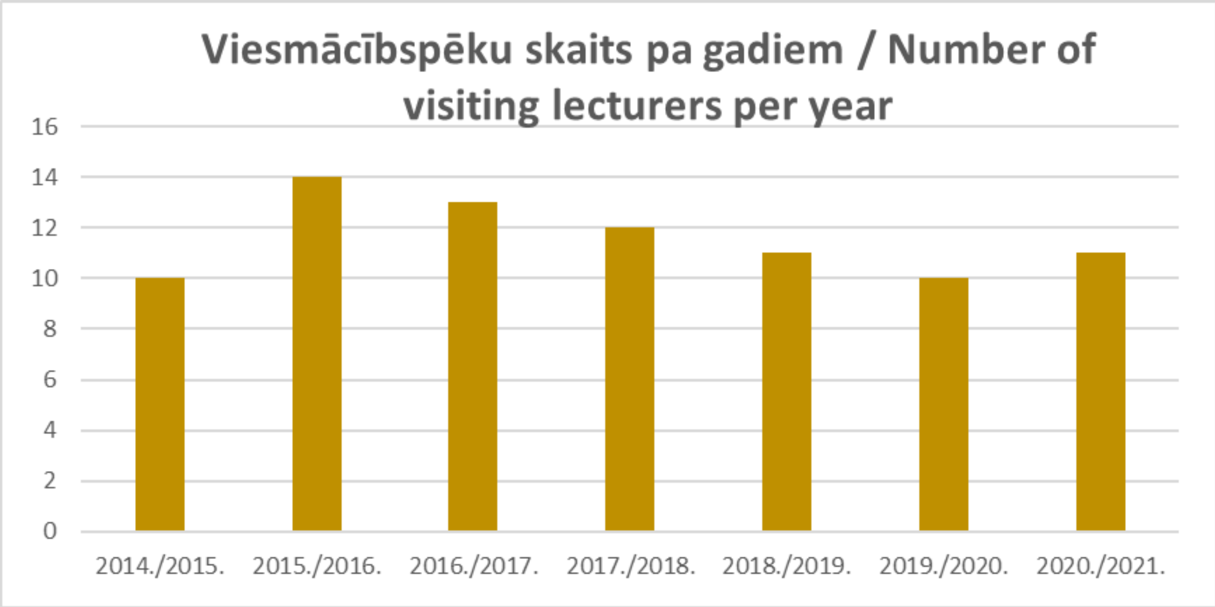


In total, the number of applications processed is much higher than the number of students actually arriving, for example, in 2015/2016, 626 applications of potential students were processed, while 349 commenced their studies, while in 2016/2017 670 applications were received and 445 were admitted. In 2017/2018, there were 1813 applications, but only 632 students entered; in 2018/2019, there were 2627 applications, but 774 students entered; in 2019/2020, there were 3340 applications and 870 students entered; in 2020/2021 there were 2036 applications and 524 students arrived. In 2021/2022, 873 students entered at 2533 applications.

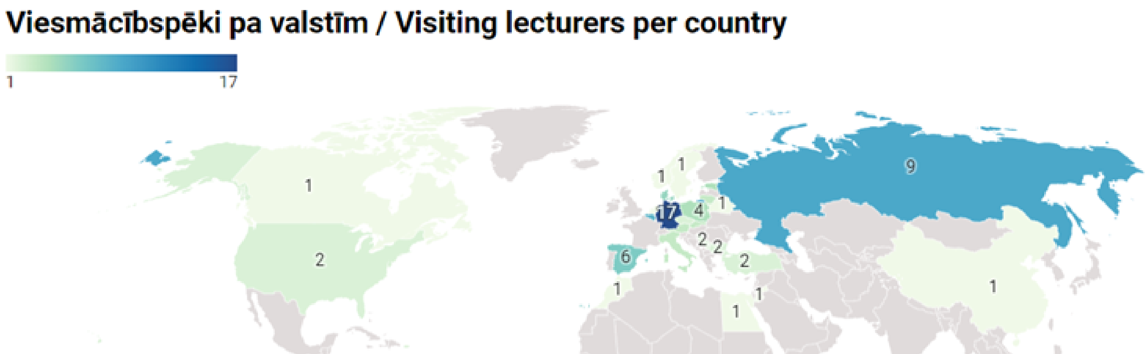
The number of students enrolled in mobility programmes also demonstrates a general increasing trend, taking into account the impact of the restrictions caused by the COVID19 pandemic in 2019-2021. Students who want to take advantage of mobility to go to study in other countries are relatively few, which is typical of the study field due to high early employment.

In addition to participating in international exchange programmes, students are given the opportunity to go on study trips abroad within the framework of the study field. Faculty students also actively participate in summer schools and other student mobility events organized by various foreign universities.

In addition to student mobility, the study field actively welcomes guest teachers in order to improve the study process and the quality of studies in general, as well as to ensure that students have access to knowledge that cannot be provided by the academic staff of the study field in an appropriate quality.



As it can be observed considering the guest lecturer dynamics, overall the number of guest lecturers is relatively stable also during the COVID19 pandemic, which indicates relatively close cooperation and mutual trust between RTU and visiting academic staff.



Visiting academic staff are mainly invited from the EU countries. In some cases, the guest staff reside outside the EU. This is due to long-term cooperation or a specific area of knowledge that is not available in cooperation partner universities from the EU countries.

During the visit, several study courses have been created, for example, DSP 793 “Introduction to Deep Machine Learning” and DSP791 “Introduction to IoT Technologies and Applications”.

The main difficulties are related to factors of a practical nature - specifically, the actual workload of the invited or sent teaching staff and researchers in the existing projects and the teaching process, which is relatively high in the Study field in general. This significantly narrows the range of employees who can be involved in mobility activities. In recent years, significant resources have been invested to involve teaching staff not only in short-term mobility events, but also in long-term ones - one or two semesters. Apart from the mentioned factors, the essential factor is the skills and knowledge of the teaching staff, which must meet the needs of the host country. Within the Study field, there is a sufficient number of such teaching staff and researchers, so their involvement is possible as long as the continuity of the existing academic processes is ensured. In order to expand the skills and abilities of the academic staff, a number of academic enrichment initiatives, including trainings outside of Latvia, have been launched within the Study field.

2.6. Implementation of the Recommendations Received During the

Previous Assessment Procedures

2.6.1. Assessment of the fulfilment of the plan regarding the implementation of the recommendations provided by the experts during the previous accreditation of the study field, as well as the assessment of the impact of the given recommendations on the study quality or the improvement of the study process within the study field and the relevant study programmes.

The study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” received accreditation in 2013. In the evaluation of experts, several recommendations were provided as for the study field as a whole as also for the study programmes separately. A summary of the key recommendations and actions taken is summarized in the table below:

Summary of recommendations: Recommendations / comment	**Measures taken**
Regular feedback from students, graduates and employers is required	- All study programmes have introduced mid-semester student surveys, which provide an opportunity to react in the middle of semester. - A mechanism for submitting student complaints and suggestions is in place, maintaining anonymity through a questionnaire, student parliament or faculty student self-governments. - The graduate survey has been implemented in all study programmes at RTU, which allows obtaining regular and systematic feedback. - Employers' involvement is implemented in different ways, including through questionnaires, an annual vote on the attractiveness of study programmes (prakse.lv), as well as through cooperation within the study process – supervision of graduation papers, participation in viva voce examination committees, participation in the Study Field Committee.
Academic staff development policy is needed	In accordance with RTU strategy and faculties strategies, academic staff development policy has been introduced, which includes measures to ensure their professional development and sustainable development.

Necessary to make greater use of multimedia content for delivery of lecture materials to students	During the reporting period, the study field has implemented several measures for the improvement of the content, including MOOC and Edx courses (developed as part of the Erasmus+ project IOT-OPEN.EU). For example, video lectures as part of a permanent course have been introduced in the course DSP703 Systems Theory and in two newly established courses DSP775 Network Security Requirements and DSP776 Information Systems Security Engineering.
Average age of academic staff	In the reporting period, the average age of academic staff has decreased significantly due to the employee retirement, as well as the end of election terms, which prevents continuing comprehensive work of an educator.
Student involvement in laboratory work should be encouraged	Many study courses have increased the number of CP so that students have more practical classes in labs within the framework of the study course. Students are also involved in various research projects. Regular renewal of laboratory equipment and use of modelling software within the framework of the program.
Mobility of academic staff should be promoted	In the reporting period, several educators were elected to visiting staff positions at foreign HEIs, e.g., A.Nikitenko and A.Anohina-Naumec were elected visiting professors at the Norwegian University of Science and Technology. Professor Marina Platonova was granted the status of a visiting fellow in digital humanities at King’s College London, which is ranked in the top 50 best world universities. In addition, RTU students, academic and administrative staff can actively participate in the EUt+ creation and work process by using the opportunities provided by Erasmus+ program in the implementation of studies, internships and staff mobility at EUt + partner universities.
Necessary to develop a foreign language learning policy	In the reporting period, English language courses for academic and non-academic staff covered by the employer (RTU) were organized, which has allowed increasing the level of language proficiency, which has been attested with an appropriate certificate.
Provision of study opportunities in the regions	The strategy of the study direction envisages a wider use of MOOC (Massive Online Open Courses) type content, supplementing the already offered range. Students may participate in face-to-face and / or distance learning and / or counseling as needed.
Content overlap in study programmes, reduction of the number of study programmes	As part of the optimization and reorganization of resources, as well as to improve the quality of study content, several study programmes have been merged (such as FCSIT 3 doctoral study programmes have been merged into one study programme), several study programmes have already been closed and several will be closed in the near future. In total, out of 38 study programmes, 26 study programmes are directed to the re-accreditation.

In addition to the given summary, a detailed overview of the recommendations (for the study direction and the study programmes) and their implementation plan is provided in the appendix *P03_2.6.1_Recommendationsoverview2013Accredit_eng.pdf* (for the study programmes accredited in 2013). Expert conclusions (reports prepared in 2013) for study programmes are stored in RTU's centralized document management system, and are also given in the supplementary annex *2013_Conclusions_Recommendations_2.6.1.zip*. Expert conclusions for the study field in general and for each study programme are available only in English.

In the reporting period from 2014 to 2022, an overview of the short-term and long-term recommendations of the licensed study programmes can be found in the annex *P03_2.6.2_Recommendationsoverview_2013-2022_LicencedStudyProgrammes_updated_eng.*

2.6.2. Implementation of the recommendations given by the experts during the evaluation of the changes to the study programmes in the respective study field or licensed study programmes over the reporting period or recommendations received during the procedure for the inclusion of the study programme on the accreditation form of the study field (if applicable).

During the reporting period (2013-2022) several study programmes were licensed:
Academic master study programme **"Digital Humanities"** (2017);
Professional bachelor study programme **“Finance Management Information Systems”** (2018);
Academic bachelor study programme **“Computer Science and Organizational Technologies”** (2019);
Professional bachelor study programme **“Smart Electronic Systems”** (2020);
Academic master study programme **"Cybersecurity Engineering"** (2020);
Doctoral study programme **“Computer Science and Information Technology”** (2021).

An overview of the long-term recommendations received during the programme licensing procedure and details of their implementation is given in Appendix *P03_2.6.2_Recommendationsoverview_2013-2022_LicencedStudyProgrammes_eng.pdf* (for the study programmes licensed during the reporting period 2013-2022).

Annexes

I - Information on the Higher Education Institution/ College		
Information on the implementation of the study field in the branches of the higher education institution/ college (if applicable)		
List of the governing regulatory enactments and regulations of the higher education institution/ college	List of internal regulations.zip	Ieksejo normativo aktu saraksts.zip
The management structure of the higher education institution/ college	RTU_Management_ Structure.pdf	RTU_Parvaldibas_Struktura.pdf
II - Description of the Study Field - 2.1. Management of the Study Field		
Plan for the development of the study field (if applicable)	P13_2.1.2_Study_field_development_plan_2022-2027.pdf	P13_2.1.2_Studiju_virziena_attistibas_plans_2022-2027.pdf
The management structure of the study field	P14_2.1.3_RTU_Study_Direction_Management_Structure_ENG.pdf	P14_2.1.3_RTU_studiju_virziena_parvaldibas_struktura_LV.pdf
A document certifying that the higher education institution or college will provide students with opportunities to continue their education in another study programme or another higher education institution/ college (agreement with another accredited higher education institution or college) if the implementation of the study programme is terminated.	P15_2.1.4_StudyContinueOpportunities_Provisionaltranslation.zip	P15_2.1.4_StudijuTurpin_StudyContinue.zip
A document certifying that the higher education institution or college guarantees compensation for losses to students if the study programme is not accredited or the study programme license is revoked due to actions (actions or omissions) of the higher education institution or college and the student does not wish to continue studies in another study programme.	Confirmation - on compensation for losses.edoc	Apliecinājums - par zaudējumu kompensāciju.edoc
Standard sample of study agreement	Study_agreements.zip	Studiju_ligumi.zip
II - Description of the Study Field - 2.2. Efficiency of the Internal Quality Assurance System		
Analysis of the results of surveys of students, graduates and employers	P18-2.2.4-StudentiAbsolventiDarbaDeveji-Aptaujas-ENG.pdf	P18_2.2.4_StudentiAbsolventiDarbaDeveji_Aptaujas_LV.pdf
II - Description of the Study Field - 2.3. Resources and Provision of the Study Field		
Basic information on the teaching staff involved in the implementation of the study field	P19_2.3.7_Macibspeki_LV_AcademicStaff_ENG.xlsx	P19_2.3.7_Macibspeki_LV_AcademicStaff_ENG.xlsx
Biographies of the teaching staff members (Curriculum Vitae in Europass format)	A20_2.3.7_CV_ENG.zip	P20_2.3.7_CV_LV.zip
A statement signed by the rector, director, head of the study programme or field that the knowledge of the state language of the teaching staff involved in the implementation of the study programmes within the study field complies with the regulations on the state language knowledge and state language proficiency test for professional and official duties.	Confirmation - knowledge of the state language.edoc	Apliecinājums - valsts valodas zināšanas.edoc
A statement of the higher education institution/ college on the respective foreign language skills of the teaching staff involved in the implementation of the study programme at least at B2 level according to the European Language Proficiency Assessment levels (level distribution is available on the website www.europass.lv, if the study programme or part thereof is implemented)	Confirmation - knowledge of the foreign language.edoc	Apliecinājums - svešvalodu prasme.edoc
II - Description of the Study Field - 2.4. Scientific Research and Artistic Creation		
Summary of quantitative data on scientific and/ or applied research and / or artistic creation activities corresponding to the study field in the reporting period.	2.4.4_Projekti(Pētījumi)Jaunrade_LV_Projects(Research)Creation_ENG.zip	2.4.4_Projekti(Pētījumi)Jaunrade_LV_Projects(Research)Creation_ENG.zip
List of the publications, patents, and artistic creations of the teaching staff over the reporting period.	2.4.4_PublikacijasPatenti_LV_PublicationsPatents_ENG.zip	2.4.4_PublikacijasPatenti_LV_PublicationsPatents_ENG.zip
II - Description of the Study Field - 2.5. Cooperation and Internationalisation		
List of cooperation agreements, including the agreements for providing internship	2.5.1_SadarbibasLigumi_LV_CooperationAgreements_ENG.zip	2.5.1_SadarbibasLigumi_LV_CooperationAgreements_ENG.zip
Statistical data on the teaching staff and the students from abroad	P25_2.5.3_Statist_ArvalstuStudejMacibsp_LV_ForeignStud_Teachstaff_ENG.pdf	P25_2.5.3_Statist_ArvalstuStudejMacibsp_LV_ForeignStud_Teachstaff_ENG.pdf
Statistical data on the incoming and outgoing mobility of students (by specifying the study programmes)	P26_2.5.3_StudMobilStatist_ienakizej_LV_incomoutgoing_ENG.pdf	P26_2.5.3_StudMobilStatist_ienakizej_LV_incomoutgoing_ENG.pdf
Statistical data on the incoming and outgoing mobility of the teaching staff	P27_2.5.3_MobilStatist_Macibsp_ienakizej_LV_Teachstaff_incomoutgoing_ENG.pdf	P27_2.5.3_MobilStatist_Macibsp_ienakizej_LV_Teachstaff_incomoutgoing_ENG.pdf
II - Description of the Study Field - 2.6. Implementation of the Recommendations Received During the Previous Assessment Procedures		
Report on the implementation of the recommendations received both in the previous accreditation and in the licensing and/ or change assessment procedures and/ or the procedures for the inclusion of the study programme on the accreditation form of the study field.	P03_2.6.1_Recommendationsoverview2013Accredit_eng.pdf	P03_2.6.1_Rekomendacijuparskats2013Akredit_lv.pdf
An application for the evaluation of the study field signed with a secure electronic signature	01000-2.2.1-e_219.edoc	01000-2.2.1-e_219.edoc
III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P5Pielikums.docx	P05_3.1.4_DBF0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.docx
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMK0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_DML0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_ECV0(42523)_AtbilstībaProfStand_ProfBak_EN.pdf	P07_3.2.1_ECV0(42523)_AtbilstibaProfStand_ProfBak_LV.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme		P08_3.2.1_DML0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_RTUkods_EStudijas_v1.docx.pdf	P09_3.2.1_RTUkods_EStudijas_v1.docx.pdf
Descriptions of the study courses/ modules	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip	A10_DBF0(43526)_StudyCoursesdescr_ENG (4).zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		

Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Other annexes

Name of document	Document
2.1.6_AkadGodigumsRiks_LV_AcademicIntegrityTool_ENG.pdf	2.1.6_AkadGodigumsRiks_LV_AcademicIntegrityTool_ENG.pdf
Zinātniskās institūcijas darbības starptautiskais novērtējums (DITF, 2019) / The international evaluation of scientific institution's activity (FCSIT, 2019)	E15_RTU_FCSIT_2.4.2.pdf
Atskaites periodā licencēto studiju programmu rekomendāciju pārskats (2013-2022).	P03_2.6.2_Rekomendacijuparskats_2013-2022_LicencetasStudprogrammas_lv.pdf
On minimal number of students in study programmes	On_minimal_number_of_students_in_study_programmes_2.3.1_3.3.3.pdf
Par minimālo studējošo skaitu studiju programmās	Par_minimālo_studējošo_skaitu_studiju_programmās_2.3.1_3.3.3.pdf
Finansējuma sadalījums starp izmaksu pozīcijām / Funding distribution between the cost items	FinansSadalijums_LV_FundingDistribution_ENG_2.3.1_3.3.3.pdf
RTU_studejoso_priek_un_sudz_iesn_un_izsk_kart.pdf	RTU_studejoso_priek_un_sudz_iesn_un_izsk_kart.pdf
RTU_proposals_complaints.pdf	RTU_proposals_complaints.pdf
Screenshots of RTU IT systems.zip	Screenshots of RTU IT systems.zip
RTU IT sistemu saskarnes.zip	RTU IT sistemu saskarnes.zip
Review of recommendations for licensed study programmes during the reporting period (2013-2022)	P03_2.6.2_Recommendationsoverview_2013-2022_LicencedStudyProgrammes_eng.pdf
Skaidrojums izglītības klasifikācijas koda maiņai	2.1.1_KlasifikKodaMaina_Skaidrojums_LV.pdf
Explanation for the change of educational classification code	2.1.1_ChangeofClassifCode_Explanation_ENG.pdf
2013. gada ekspertu atzinumi	2013_Conclusions_Recommendations_2.6.1.zip
Review of recommendations for licensed study programmes during the reporting period (2013-2022) (updated)	P03_2.6.2_Recommendationsoverview_2013-2022_LicencedStudyProgrammes_updated_eng.pdf
Atskaites periodā licencēto studiju programmu rekomendāciju pārskats (2013-2022) (papildināts)	P03_2.6.2_Rekomendacijuparskats_2013-2022_LicencetasStudprogrammas_papildinats_lv.pdf
Finansējuma sadalījums starp izmaksu pozīcijām (papildināts)/ Funding distribution between the cost items (updated)	FinansSadalijums_LV_FundingDistribution_ENG_2.3.1_3.3.3_papildinats_updated.pdf
01000-2.2.1-e_219.edoc	01000-2.2.1-e_219.edoc
Par uzņemšanas prasību izmaiņām doktora studiju programmā "E-studiju tehnoloģijas un pārvaldība".edoc	Par uzņemšanas prasību izmaiņām doktora studiju programmā "E-studiju tehnoloģijas un pārvaldība".edoc
P08_3.2.3_DBT(43483)_Studiju_kursu_kartejums.pdf	P08_3.2.3_DBT(43483)_Studiju_kursu_kartejums.pdf
P07_3.2.1_DCP0(42484)_AtbProfStand_LV_ComplOccupationalStand_ENG.docx	P07_3.2.1_DCP0(42484)_AtbProfStand_LV_ComplOccupationalStand_ENG.docx
Choice of Study Modules_DH_.xlsx	Choice of Study Modules_DH_.xlsx
Choice of the Study Module_DH.docx	Choice of the Study Module_DH.docx
Free Elective Study Course DH.xlsx	Free Elective Study Course DH.xlsx
Study module Choice Students info.docx	Study module Choice Students info.docx
AvailableInfrastructureVer02.pptx	AvailableInfrastructureVer02.pptx
Facilities_RTU_RBS.pdf	Facilities_RTU_RBS.pdf

Computer Systems (47526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Systems*
Education classification code	*47526*
Type of the study programme	*Professional master study programme*
Name of the study programme director	*Egons*
Surname of the study programme director	*Lavendelis*
E-mail of the study programme director	*Egons.Lavendelis@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089548*
Goal of the study programme	*The aim of the study programme is to prepare professionals in accordance with the 5th level leading programming engineer professional qualification standard (majoring in applied computer system software and in applied computer science) or system analyst professional qualification standard (majoring in Computer System Design) with deep professional expertise in computer science, software engineering, system analysis, computer system development, database technologies, programming languages, software development environments, as well as with ability to participate in software development project fulfilling different (including manager) roles, who demonstrate professional ethics and knowledge/skills complying with IT industry standards. Prepare students for the continuation of studies at Doctoral studies level.*

Tasks of the study programme	*Study programme tasks are the following:* *- To provide knowledge in system analysis, as well as in design and development of the information systems, database systems and intelligent systems (majoring in System Design).* *- To provide knowledge in software products, systems and development environments, as well as in technologies and tools for applied software development (majoring in Applied Computer Systems Software).* *- To provide knowledge in problem analysis, computer systems modelling and programming methods (majoring in Applied Computer Science).* *- To train students in professional usage of the systems' development tools (majoring in System Design).* *- To train students in professional usage and development of the complex software products (majoring in Applied Computer Systems Software).* *- To train students in practical usage of the computer systems modelling and programming methods (majoring in Applied Computer Science).* *- To provide practical work experience for the students (longer internship for graduates of academic Bachelor study programme).* *- To improve students' oral and written communication skills as well as to develop students' skills in team work.* *- To promote understanding of the professional ethics and IT industry standards, as well as compliance to them in professional activities.* *- To give opportunity to obtain the qualification "Leading Programming Engineer" or "System analyst", by developing Master Thesis including project, in which a student carries out research, demonstrating skills to integrate the acquired theoretical knowledge into practice.*
Results of the study programme	*Graduates of this study programme will:* *- Acquire deep theoretical and practical knowledge in system analysis and design of the information systems, database systems and intelligent systems, as well as are able to perform already existing business system analysis, client and user interviews;* *- Acquire deep theoretical and practical knowledge in programming, software systems and development environments, as well as in technologies and tools for application development;* *- Be able to use different system development methods and tools for the system analysis and modelling tasks;* *- Be able to develop and professionally use complex software products;* *- Be able to use methodologies and tools based on object-oriented, functional or logical paradigm in the development of computer systems;* *- Be able to independently define and critically analyse scientific and professional problems;* *- Be able to choose the appropriate software products, tools and methods (including artificial intelligence methods) for solving problems;* *- Be able to organize and manage group of software developers by applying professional standards, analyse work results and to provide risk management plan;* *- Be able to improve independently their competencies.*

Final examination upon the completion of the study programme	*To receive the professional degree of Master of Engineering in Computer Systems, students must accomplish the syllabus and internship, and work out and defend their Master Thesis. Master Paper consists from two parts: research part and project part. Master Thesis may be the starting point for Doctoral studies. The volume of the Master thesis including project is 20CP. A reviewer with doctoral degree is appointed for evaluation of the thesis.*

Study programme forms

Full time studies - 1 years, 6 months - latvian

Study type and form	*Full time studies*
Duration in full years	*1*
Duration in month	*6*
Language	*latvian*
Amount (CP)	*60*
Admission requirements (in English)	*Professional Bachelor Degree in Computer Systems or comparable education and professional qualification of Programming Engineer*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master Degree in Computer Systems*
Qualification to be obtained (in english)	*Systems Analyst or Leading Programming Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree of Engineering Science in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems or comparable education; or Bachelor Degree of Engineering Science in Electrical Engineering, or Bachelor Degree of Natural Sciences in Computer Science, Mathematics, Physics or comparable education by fulfilling additional requirements*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master Degree in Computer Systems*
Qualification to be obtained (in english)	*Systems Analyst or Leading Programming Engineer*

Places of implementation

Place name	City	Address

Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

Along with the change of education field classification, the educational classification code of the study program was changed within the evaluation procedure of the study field to 47526 – other engineering sciences. This change was made in view of the fact that the professional Master study program “Computer Systems” basically covers computer systems development technologies necessary for programming engineers and systems analysts. A study of various sources, including university curricula in the European Union and other countries, reveals that today information and communication technologies is a branch of engineering sciences that aims to develop and research methods, tools, approaches, technologies and technical solutions to solve practical problems in order to improve people’s living conditions. This distinguishes information and communication technology as an engineering discipline that uses scientific knowledge to solve practical and technical problems in order to create objects that do not exist in nature, from natural science, which studies the patterns and phenomena that exist in nature. Moreover, leading programming engineers and system analysts represent a profession of an engineer who creates new computer systems.

In accordance with Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Professional Higher Education of the Second Level”, the volume of the program has been changed from the historically established 62 CP in 2013 to 60 CP in 2022. Whereas, the duration of the second variant of the program implementation has been reduced from 2.5 years in 2013 to 2 years in 2022, correspondingly reducing the program volume from 104 CP to 80 CP. The admission requirements have been specified as well, determining that, in the first variant of the program, applicants with the professional Bachelor degree in computer systems or the equivalent education and the qualification of programming engineer are admitted, but in the second variant of the implementation, applicants with the Bachelor degree of engineering science in computer control and computer science, computer systems, information technology, intellectual robotized systems or the equivalent education are admitted; or the Bachelor degree of engineering science in electrical engineering, or the Bachelor degree of natural sciences in computer science, mathematics, physics or the equivalent education, by fulfilling additional requirements. Regarding additional requirements, it has been determined that students need to acquire the following study courses: “Programming” (2 CP), “Databases” (2 CP), “Mathematics” (3 CP), “Fundamentals of System Analysis” and/or “Artificial Intelligence” (2 CP). If an entrant has not completed the study courses in the respective fields at least in the provided volume, these need to be completed in addition to the program volume prior to entering the program or during the first semester.

Given the dynamic nature of the field of information technology, the content of the study program curriculum and of each study course is regularly reviewed. At the level of the study program, a regular assessment is made of the relevance of the existing study course to the current situation in the field and research area. If an existing study course is found to be outdated or for any other reason does not fulfill its intended role in achieving the objectives of the study program, it is replaced by a new study course or its curriculum is significantly changed. At the level of study course, each responsible instructor reviews the curriculum of their course regularly to ensure that it is up-to-date with the latest technologies and trends in the field. When significant changes are made to a study course, they are discussed at the Council of the Institute of Applied Computer Systems so that all organizational units implementing the study program are aware of the changes and so that consistency between study courses within the program can be ensured.

In early 2022, a workgroup organized by LIKTA developed new occupational standards of the leading programming engineer and system analyst. In conformity with the new standards, the qualification awarded upon the completion of the study program has been changed, awarding all graduates the qualification corresponding to the 7 LQF level. Following the changes, students of the program who select the specialization “Design of Computer Systems” obtain the qualification of system analyst, and students who select the specialization “Applied Computer System Software” or “Applied Computer Science” obtain the qualification of leading programming engineer. There is no more variant of the program offered without obtaining a new qualification, which was earlier possible in the case the student already had the qualification of programming engineer appropriate for the program.

The curriculum of the study program was considerably redesigned to bring it in compliance with the new standards and Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Professional Higher Education of the Second Level”. The program is built in such a way that its first or basic variant includes obtaining the knowledge that is required for a programming engineer to obtain the qualification of a leading programming engineer or system analyst. A compulsory part of the program includes the knowledge and skills required for obtaining both qualifications, and the study courses that develop skills unique for each standard are included in the compulsory elective part. Whereas the second variant of the program is organized in such a way that students obtain the fundamental technical and professional knowledge and skills, as well as practical experience within the framework of internship, thus complying with the qualification of programming engineer.

Based on Section 6 of RTU Internal Code of Student Conduct, RTU Code of Academic Integrity and RTU Study Department’s guidelines “Breach of Academic Integrity and Breach Consideration Procedures”, since 2021 an enhanced plagiarism control has been introduced for graduation papers. In 2019, a procedure for reviewing academic integrity violations was adopted (FCSIT Council Decision No. 12000-1.1/9 of 14 June 2019 “On the Procedure for Reviewing Cases of Plagiarism in Graduation Papers of Students at the Faculty of Computer Science and Information Technology of RTU”), ensuring objective review of the violations. Since 2021, electronic plagiarism control has also been introduced for all student papers. An electronic system developed at the Institute of Applied Computer Systems is used for this purpose.

As the program is implemented in full-time on-site mode, in order to ensure that at least 40% of the workload is completed in contact hours, the semester planning has been changed from a 4-week examination period to a single 20-week semester plan for mastering the study course curriculum and examinations in the autumn and spring semesters.

With account of the tendencies that students often do not continue their studies at the Master level, which results in a comparatively low total number of students, as well as the fact that in recent years, there is no demand for part-time on-site studies, a transfer has been performed to one form of the program implementation – full-time on-site studies, liquidating part-time on-site studies. In accordance with the Cabinet of Ministers Regulation No 111 (of 8 February 2022) “Procedure for the Organization and Implementation of Remote Studies”, it is planned to partly implement some study courses with a small number of students in the format of remote studies, thus also adjusting to the needs of the students who cannot attend all classes anticipated for the implementation of a full-time on-site program due to their full-time load at work.

The other main parameters of the program – place of implementation, language of instruction (only Latvian) – remained unchanged during the evaluation period.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The volume of the study program of 60 CP and its duration of 1.5 years are in compliance with Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Professional Higher Education of the Second Level”. Such duration and volume of the program allow in the shortest possible time covering the skills defined by the standards of leading programming engineer or system analyst, which are not included in the standard of programming engineer and are not obtained within the professional Bachelor studies, where graduates obtain the qualification of programming engineer. Acquisition of skills takes place during the study courses included in the program and the internship that allows young specialists to start working in the industry as soon as possible, which is especially significant with account of the high demand for young highly qualified specialists in the industry. Whereas, applicants having an academic Bachelor degree in the respective field are offered the program implementation variant in the volume of 80 CP during full two years. In this implementation variant, students additionally obtain professional skills and undertake the internship in the volume of 20 CP.

The offer of two qualifications – leading programming engineer and system analyst – results from several factors, namely a high demand for specialists in the IT industry, which is determined by the development trends of the state and the IT industry, as well as the professional growth of specialists. The IT industry is currently facing difficulties in attracting qualified specialists, for example, as Aivis Brodiņš, head of CV-Online Latvia, noted to the newspaper "Dienas bizness" (June 9, 2022), the number of IT vacancies on the portal has increased, but the number of applications has not changed. According to the informational report of the Ministry of Economy "On medium and long-term forecasts of the labor market" (2020), this situation will remain in 2040 as well. This means that the number of specialists who meet the qualification requirements of a leading programming engineer and system analyst is low in Latvia. The lack and/or low qualification of leading programming engineers and system analysts is also the reason why large and complex information systems development projects often end in failure. The main reasons are difficult communication with the customer's representatives, defects in the design, inappropriate work organization and the inability to see and mitigate the risks of the project in a timely manner. The qualification of a leading programming engineer and system analyst requires the development of skills and abilities to see and mitigate those risks in the certain stages of project development. Thus, for instance, a lead programming engineer and a systems analyst jointly participate in systems design, but a systems analyst can mitigate risks related to the accuracy and completeness of requirements, while a lead programming engineer can evaluate the compliance of technologies and solutions with requirements. Therefore, the study program is also designed to provide students with common knowledge in project management and design and development approaches and technologies, as well as in-depth knowledge in specialized risk areas – for the system analyst qualification in system design, for the leading programming engineer qualification in development technologies and approaches.

The study program corresponds most closely to the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, as the curriculum of the study program focuses on software engineering and includes knowledge and skills relevant to information technology, computer science and, to some extent, computer engineering and computer control.

The title of the study program “Computer Systems” covers all areas related to software engineering. Computer systems development requires knowledge in computer science, information technology, computer engineering and computer control. The program focuses on computer systems development (systems analysis, systems modeling, design, and algorithmization).

The aim of the study program is to train highly qualified specialists in compliance with the standards of the 5th qualification level – leading programming engineers (majoring in applied computer systems software and applied computer sciences) or in compliance with the occupational standard for the systems analyst (majoring in computer system design) with profound knowledge and skills in computer science, software engineering, system analysis, computer system development, database technologies, programming languages, software development environments, as well as capability to participate in a software development projects, fulfilling duties in different positions (including managerial) and observing the IT industry standards and professional ethics, as well as to educate and train students for continuing studies at PhD study programs.

The classification code of the study program Computer Systems is 47526 - Engineering Sciences and Technologies (other Engineering Sciences), it was chosen because the aim and curriculum of the program are related to the development of computer systems, which is the creation of engineering solutions to solve specific problems of public importance, which by their nature fall in the scope of engineering sciences. The program graduates are awarded the professional Master degree in computer systems and the 5^{th} level qualification of a leading programming engineer or a system analyst.

The aim of the study program is achieved by performing all the study program's tasks. The tasks of the study program envisage the provision of deep knowledge, the development of specialized professional and communication skills and abilities necessary to achieve the goal in study courses and internship accordingly the requirements of a professional qualification, as well as conducting independent research within the framework of a master's thesis. The study results are developed according to the tasks and verified in study courses, internship and during the defense of the master’s thesis.

The admission process is regulated by the “Rules for Admission for Post-Graduate Academic and Professional Study Programs” approved by the RTU Senate in its Decision No 655 of 25 October 2021. Admission requirements in the first program implementation variant (amounting to 60 CP) have been changed to professional Bachelor degree in Computer Systems or compatible education and the qualification of an engineer. Applicants with the Bachelor of Engineering degree in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering or compatible education, or Bachelor of Natural Science degree in Computer Science, Mathematics, Physics or compatible previous education may enroll in the second program implementation variant. In addition, it is required that the student has completed study courses in the following study fields: “Programming” (2 CP), “Databases” (2 CP), “Mathematics” (3 CP), “Fundamentals of Systems Analysis” and/or “Artificial Intelligence” (2 CP). If the candidate has not completed study courses in the respective study field at least in the specified volume, they must be completed in addition to the study program before entry to the program or during the first semester of studies. Such an approach allows both admitting as a wide circle of potential applicants as possible and offering all admitted students the corresponding curriculum to obtain the qualification of a system analyst or leading programming engineer.

Since 2013, the following enterprises provided internship opportunities to the students of the program (keeping a company name as it was at that moment): Accenture Latvian Branch, JSC DNB banka, JSC Idea Port Riga, JSC Luminor Bank, JSC OpusCapita, Institute of Electronics and Computer Science, Central Statistical Bureau of the Republic of Latvia, National Armed Forces, Pauls Stradiņš Clinical University Hospital, Picanova GmbH branch "Picanova Baltics", Ltd 001A, Ltd ABC Software, Ltd AdEvo, Ltd AGroup, Ltd Amber Games, Ltd AppXite, Ltd Atea Global Services, Ltd Autentica, Ltd Avenatora, Ltd BilderlingsPay, Ltd BookingGroup, Ltd C.T.Co, Ltd Client Line, Ltd CTE, Ltd DATAMED, Ltd Datu Sistēmas, Ltd DYNINNO, Ltd Dziedniecība, Ltd EncontrolBaltic, Ltd Enols, Ltd Evolution Latvia, Ltd First Data Latvia, Ltd FoxoDevelopment, Ltd GeidansSolutions Latvia, Ltd HORTUS Digital, Ltd Infinite Software, Ltd IntelligentSystems, Ltd Intrum Justitia Software Development Centre, Ltd It Happens, Ltd IT Sapiens, Ltd ITnT, Ltd Lattelecom Technology, Ltd Mark Media, Ltd MeaWallet Latvia, Ltd Meditec, Ltd Mikrotīkls, Ltd Mykoob, Ltd Norgate.lv, Ltd OpusCapita Competence Center, Ltd Rigvir, Ltd Software Plus, Ltd SQUALIO CLOUD CONSULTING, Ltd SWH SETS, Ltd Tele2 Shared Service Center, Ltd TestDevLab, Ltd Tieto Latvia, Ltd Tilde, Ltd UniCredit Leasing, Ltd WeAreDots, Ltd Web Building, Ltd Wonderland Media, Ltd ZZDats, State Land Service, SJSC Latvian Railway.

The duration of the variants of the study program (60 CP and 1.5 years as well as 80 CP and 2 years) is sufficient so that applicants with the indicated education can acquire and improve the theoretical and practical knowledge, skills and abilities expected as the results of the study program to the full extent, as well as obtain the necessary qualifications in accordance with the legislative requirements of Latvia. In the second variant of the study program, the list of applicants' accepted education is extended. This flexibility of the study program will allow attracting the larger number of potential students and providing the state with the necessary number of specialists and lead specialists in the IT industry.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 stipulates that ICT advances and their widespread availability are a catalyst for change in the economy, public administration and society as a whole. The knowledge society, through the targeted application of ICT solutions, transforms existing and creates new processes, business models, habits and culture in all spheres of the economy and life. Digital transformation is the key to productivity, economic growth, individual and societal well-being. At the same time, the number of ICT professionals in Latvia, according to the European Commission’s Digital Economy and Society Index, was only 2.2% of the workforce in 2018, well below the European Union (EU) average of 3.7%. The study “Future Goals, Current Directions. Latvia 2022” conducted by the think tank Certus in 2017, revealed that IT sector in Latvia needs up to 3,000 new graduates per year.

According to the Latvian statistics portal, the share of companies employing ICT/IT specialists has increased by 5% in the last 7 years and has reached 73% in 2020. According to the study "Competitiveness of Regions. Latvia Competitiveness Report 2019" conducted by Certus in 2019, the salaries of ICT professionals in leading EU countries are about 30% above the national average, in Latvia the gap is 80%.

Graduates of the Master study program "Computer Systems" are well prepared for building their career in the senior positions in ICT companies. The study program provides students with the knowledge and skills to equip them for the position of leading specialists. According to the Ministry of Education and Science data on 2017 and 2018 graduates, on average 93% of the graduates are employed one year after graduation, 97% of them in higher qualification professions according to the Ministry's classification. The average income one year after graduation is above EUR 28,000 per year and two years after graduation above EUR 29,000 per year. The share of unemployed is 0.04%. The share of graduate emigration is 0.03%. When assessing the employment of graduates by NACE codes, it can be concluded that more than 50% work in the Information and Communication Services sector (J), which corresponds most closely to the profile of the study program. In addition, the second largest number of graduates work in the Agriculture, Forestry and Fishery sector (K) and public governance and defense, including mandatory social security, which nowadays intensively develop ICT solutions. In addition, many graduates also work in the IT departments of companies in other sectors. It can therefore be concluded that graduates are mostly working in their major, working in higher qualification professions already one year after graduation, and earning salaries that are well above the national average.

Possibilities to acquire two different qualifications enable preparing two types of high level specialists for IT sector. The common skills for leading programming engineer and systems analyst are acquired in the compulsory study courses and specific skills for each qualification in field specific compulsory elective study courses. Specializations that ensure acquiring the qualification of leading programming engineer prepare senior level specialists for positions like leading programmer, development team leader. While specialization design of computer systems ensures acquiring qualification of systems analyst that allows to take such senior positions as systems analyst, IT architect, and after acquiring the necessary experience also project lead.

It is very easy for graduates of the study program to get involved in the labour market, which is proven by a large number of available vacancies of above mentioned senior positions in Latvia and abroad. In cv.lv (one of the largest job advertisement portals in Latvia), 840 vacancies in the IT field have been published in August of 2022. Positions of different levels in various IT subsectors are offered by Latvian companies and Latvian branches of international companies, such as Accenture (40 vacancies), ATEA (30), EIS group (17). From the offered vacancies, graduates of the study program can apply for various senior specialist vacancies (~550 vacancies), such as senior programmer, development team leader, system analyst, IT architect, project manager, data scientist. A very large number of vacancies are also available abroad, for example, LinkedIn offers 10,000 mid- and senior-level software developer vacancies in the UK and 5,000 in Germany, and together these countries offer more than 20,000 senior system analyst vacancies, as well as 20,000 data scientist vacancies.

Overall, more than 200 graduates of the study program "Computer Systems" expressed a positive view of the program in all questions in the 2020 survey. On a scale of 5, such aspects as the availability of necessary information during studies (4.11), the availability of literature (4.22), the provision of classroom aids (4.30) and the work of academic staff with the e-learning environment (4.10) were highly rated. Students were also generally satisfied with their choice to study at RTU (3.90), their choice to study in the study program "Computer Systems" (4.30). Students are satisfied with the theoretical (3.50) and practical (3.40) knowledge they have acquired, the schedule of the lectures and the facilities (3.90) in which the lectures were held. It should be noted that since the survey was carried out, the Faculty has moved to new premises, so due to the pandemic, at the time of writing of this report, students have not yet been able to fully experience the learning process in the new location.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The professional Master study program “Computer Systems” was implemented in Latvian in full-time form during the reporting period. All students study on the state budget. It attests to the study program accessibility for all young people who wish to study engineering sciences.

During the reporting period, it has not been possible to establish positive dynamics in the number of students due to the early employment of students in IT companies. Most students have already managed to enter the labor market during their undergraduate studies. According to CV.lv data, well-paid professional vacancies without requirement of a Master degree are widely available in IT. Consequently, graduates with a Bachelor degree are focusing on developing their professional careers rather than continuing their studies. To increase the motivation of students to study at the study program, the study duration for the second implementation variant has been decreased from 2.5 to 2 years, as well as a new qualification of a leading programming engineer is awarded. Therefore, all graduates of the program obtain the qualification corresponding to the 7^{th} LQF level.

During the reporting period, the number of graduates fluctuated from 4 to 15, which is related to the reduction of the number of enrolled students and different external circumstances, including student inability to combine studies with work and other activities, the COVID pandemic in the last two years which caused difficulties for students to complete their graduation papers in due time in the remote work and study mode.

During the reporting period, the number of exmatriculated students fluctuated from 12 to 27, which on average makes 29% of the total number of students. In most cases, students have been exmatriculated due to academic failure, which happens in the event a student cannot cope with the requirements of the study courses due to different reasons. The largest dropout in the number of students was observed during the first study year, which was mostly caused by academic failure. In total, 110 students, or 20% of the total number of students have been exmatriculated for academic failure during the reporting period (see Annex P05 – Statistical Data on Students Enrolled in the Professional Master Study Program “Computer Systems”). Students mostly mention a high load that occurs from combining their full-time work and full-time studies as a reason for their failure to fulfill the requirements of the study program. The second most frequent reason why students are expelled is failure to resume studies after an academic leave. There are 4-7 of such students every year. The third most popular reason for exmatriculation is students’ own will. The number of such students in the reporting period was in the range from 1 to 5. No other pronounced tendencies have been identified, the reasons for extending or terminating studies are different each year. It has to be taken into account that students in the respective major are often employed full-time in the industry and also go for long-lasting business trips. Other reasons for drop-out account for no more than 1 student per year.

Charts with the statistical data on the number of students in the professional Master study program “Computer Systems” are available in Annex P05 “Statistics on the Students of the Professional

Master Study Program “Computer Systems”.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Study program curriculum complies with Cabinet Regulations No 512 of 26 August 2014 “Regulations on the Second Level Professional Higher Education Standard”. The compliance is described in Annex P06 “Compliance of the Professional Master Study Program “Computer Systems” with the State Education Standard”. The study courses included in the study program were developed in compliance with the valid normative acts: Cabinet Regulations No 322 of 13 June 2017 on the Classification of Latvian Education, the Law on Institutions of Higher Education (current version), RTU Study Regulations, Regulations of the Study Course Register and RTU Senate decision on Evaluation of Learning Outcomes of 27 May 2017.

The goals and tasks of the study programme have been defined according to the qualifications that students acquire by graduating from the programme, namely Systems Analyst and Leading Programming Engineer. Acquiring the qualification of Systems Analyst is ensured by achieving the goals corresponding to the compulsory part of the programme and the goals corresponding to the specialization “Computer Systems Design”. Similarly, the goals of the compulsory part of the programme together with the goals of the specializations “Applied Computer System Software” and “Applied Computer Sciences” ensure acquiring the knowledge and skills necessary for Leading Programming Engineer.

Study course descriptions are regularly updated in line with the needs of the industry, the labor market and trends in the field of computer science and information technology as well as updated according to the new versions of the occupation standards of Systems analyst and Leading programming engineer. Considering the rapid changes in the IT industry and technological developments, study courses are regularly updated and study program curriculum is modified, thus ensuring that the study program meets the needs of the labor market and the trends in the IT field. Some examples of changes:

- The academic staff keep abreast of the use of programming languages and other technologies in the industry, adapting the languages and technologies used to deliver the study courses accordingly.
- To better train students to work in a project-oriented environment in the IT industry, within the study courses, students have to work in teams to solve software development problems and project management tasks.
- Creativity and critical thinking of students are developed, applying design thinking principles at the practical classes.

Part A of the first implementation variant of the study program includes compulsory study courses, where students obtain knowledge and skills complying with the occupational standards of both system analyst and leading programming engineer in the volume of 20 CP. Part A of the second variant of the program accounts for 23 CP and includes also study courses for obtaining technological fundamental knowledge of the industry. Study courses of Part B1 of the program are grouped by three specializations – Design of Computer Systems, Applied Computer System Software and Applied Computer Sciences. Every student selects compulsory elective study courses appropriate for the specialization and obtains the corresponding qualification – Design of Computer Systems corresponds to the qualification of system analyst and the other two specializations correspond to the qualification of leading programming engineer. The role of compulsory elective study courses is to obtain different knowledge and skills complying with the occupational standards of system analyst and leading programming engineer. In the first implementation variant of the program, part B1 accounts for 10 CP, and in the second variant, its volume is 7 CP. Part B2 in the volume of 4 CP allows students to select humanitarian and social study courses that develop their basic social, communicative, and organizational skills.

With regard of the fact that the study program has a professional inclination, a minimum of 50% of classes in professional study courses are practical and laboratory works. Moreover, during the lectures, the academic staff devote special attention to the usage of technologies for solution of real tasks, thus ensuring that a leading programming engineer or a systems analyst master the required knowledge and skills as efficiently as possible.

As already described in 3.2.6 “Analysis and assessment of the topics of the graduation papers”, the academic and scientific staff of the Institute of Applied Computer Systems (IACS) follow the latest trends in IT research and propose themes for the graduation papers corresponding to them, including the development of a software prototype or product for the real needs of the public or businesses.

Consequently, the aims, objectives, and learning outcomes of all parts of the study program lead to the achievement of the learning outcomes and the overall aim of the study program, as well as the fulfillment of the tasks. Regular analysis and updating of the study courses eliminate their possible overlapping and duplication. The mapping of the learning outcomes of the study courses against the program learning outcomes is given in Annex P08 “Mapping of study courses for the study program “Computer Systems””. The mapping indicates that the learning outcomes contributing most to the program outcomes are related to planning and organizing, scientific and professional problem solving, different theoretical and practical knowledge, as well as application of methodologies and tools: “be able to organize and manage group of software developers by applying professional standards, analyze work results and to provide risk management plan” (supported by more than 80 learning outcomes), “be abile to independently define and critically analyze scientific and professional problems” (supported by more than 70 learning outcomes), “acquire deep theoretical and practical knowledge in system analysis and design of the information systems, database systems and intelligent systems, as well as are able to perform already existing business system analysis, client and user interviews” (supported by more than 60 learning outcomes), "be able to use methodologies and tools based on object-oriented functional or logical paradigm in the development of computer systems“ (supported by more than 60 learning outcomes). The least support is for program outcomes “acquire deep theoretical and practical knowledge in programming, software systems and development environments, as well as in technologies and tools for application development” and "be able to use different system development methods and tools for the system analysis and modeling tasks“ (both supported by 40 learning outcomes) which is related to the fact that programming knowledge is acquired more at the previous study level and a greater focus on the topics of systems analysis and modeling is in the qualification “Systems Analyst”. Detailed descriptions of each study course are given in Annex P10.

In Annex P07 Professional Master’s study programme “Computer Systems” has been evaluated for compliance with two Occupational Standards, namely, standard of Leading Programming Engineer and Systems analyst because depending on the chosen specialization graduates receive different qualifications. Graduates of the specialization “Design of Computer Systems” receive qualification of Systems Analyst while graduates of specializations “Applied Computer System Software” and “Applied Computer Science” receive qualification of Leading Programming Engineer. According to the Latvian ICT association LIKTA the current version of the occupational standard “Systems Analyst” (approved in 2002) is outdated and does not reflect the actual needs of the industry. Also at the moment there is no approved occupational standard “Leading Programming Engineer” in Latvia. Therefore, the study program has been evaluated based on a working versions of the occupation standards developed by a working group organized by LIKTA and submitted for the approval in March 2022. The approval of the standards should be done in 2022. The analysis showed that the study courses included in the study programme ensure that students fully acquire knowledge necessary for performing professional tasks of Leading Programming Engineer or Systems Analyst depending on the chosen specialization. The working versions of the standards used for the evaluation are added as an additional annexes.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The professional Master study program “Computer Systems” provides higher professional education rooted in fundamental and applied research in computer science and information technology, as well as technologies and knowledge required for the IT industry. The program allows students to obtain the qualification of either a leading programming engineer with specialization in applied computer system software or applied computer sciences or the qualification of a system analyst with specialization in design of computer systems.

Master degree studies allow working as a leading programmer or the head of a workgroup of programmers (the qualification of a leading programming engineer) or system analyst (the qualification of system analyst), as well as working as a researcher and continuing PhD studies. Students are provided with the required knowledge of a leading programming engineer or system analyst (depending on the selected specialization), which has not been mastered when obtaining the qualification of programming engineer. The study program ensures also the acquisition and integration of profound theoretical and practical knowledge, ensuring that the graduate is capable of implementing and applying in practice theoretical concepts of computer sciences to solve complex problems, as well as to supervise the work of their subordinates.

The aim of the study program is to train highly qualified specialists in compliance with the standards of the 5th qualification level – leading programming engineers (majoring in applied computer systems software or applied computer sciences) or in compliance with the occupational standard for the systems analyst (majoring in computer system design) with profound knowledge and skills in computer science, software engineering, system analysis, computer system development, database technologies, programming languages, software development environments, as well as capability to participate in a software development projects, fulfilling duties in different positions (including managerial) and observing the IT industry standards and professional ethics, as well as to educate and train students for continuing studies at PhD study programs.

The study program ensures that the curriculum of the study courses is up-to-date and relevant to the needs of the labor market and the latest achievements and knowledge in the field of computer science and information technology.

Upon completion of the Master studies, the students need to develop and defend their Master Thesis with a project part in the amount of 20 CP (earlier the Master Thesis with a project part in the amount of 26 CP or the Master Thesis in the amount of 20 CP, if the student does not obtain a new qualification). The Master Thesis with a project part is a combination of independent research and practical development, which is developed through direct cooperation with academic and research staff of the Institute of Applied Computer Systems, with account of the industry needs and topical problems of the field. The research performed in the Master Thesis and its presentation demonstrate the student's ability to analyze, classify, compare ideas rendered in scientific research and technical resources in the field of computer science and information technology, to obtain, summarize, analyze and assess data by applying methods, methodologies, technologies, computer systems and development tools and languages to solve tasks, formulate problems, integrate the obtained knowledge and express assumptions on possible innovative solutions to these problems. Whereas the project part of the Master Thesis demonstrates the student's ability to fulfill the work tasks of a system analyst or leading programming engineer in practice, performing development and/or analysis of the specific system. As a result of the Master Thesis, students propose a scientific innovation in the field of computer science and information technology. The Master Thesis must be designed in such a way that its results can be published. The awarding of the degree and qualification is based on the public presentation of a reviewed research – the Master Thesis with a project part – and the results of the study course examinations.

Master Theses are related to the current issues in the field of computer science and information technology. During the reporting period, the following theses were awarded the grade "with distinction":

- Information system models and projects – "EMV Project Development", "Communication Device Design in the Context of Socio-Cyber-Physical Systems";
- Assessment and analysis of technology and algorithm application – "Tool Development to Support the Docker Container Technology";
- Data processing and storage – "Analysis of the Deductive Database Implementation in the Object-Relation Database Environment", "Research of Business Information Data Visualization System", "Development of Data Analytics Task Methods in the Information Repository Design";
- Development of software systems for different areas – "Development of Mobile Version Support System for the State Examination Commission", "Room and History Functionality

Development for Web Chat", "Development of Rude Words Filtration and Friendship Algorithms for Web Chat", "Development of Transport Freight Forwarding Information System", "Development of User Support System", "Development of Freight Vehicle Tracking Support System", "Development of Order Management System for Sliding Door Products", "Development of Worktime Accounting System", "Development of Support System for the Student Scientific Conference of the Institute of Applied Computer Systems", "Development of Cloud-Based Freight Vehicle Management System", "Development of Tachograph Data Examination Possibilities for the SkyFMS System", "Development of 3D Scanning Application for Mobile Devices with iOS Operational System".

The topics of the Master Thesis are described in more detail in Section 3.2.6.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The contents of the study programme are defined correspondingly to the goals of the study programme and both qualifications that the graduates can acquire, namely Systems Analyst and Leading Programming Engineer. Based on the compulsory part of the study programme the students acquire the common knowledge and skills necessary for both Systems Analysts and Leading Programming Engineers. The compulsory elective study courses of the specialisation "Computer Systems Design" ensure acquiring the necessary knowledge and skills for the systems analyst while the compulsory elective courses of other specializations ("Applied Computer System Software" or "Applied Computer Science") teach the knowledge and skills necessary for leading programming engineers according to the professional standard.

Implementing the study process, the responsible instructor of the study course determines the assessment criteria and methods for the acquisition of the study course. The student is informed about the assessment procedure for each study course in the e-environment at the beginning of studies. When planning the study process, the responsible instructor determines the pedagogical methods for mastering each topic to be addressed within the study course.

The study process is implemented in the following modes: lectures, practical classes, laboratory and independent work implemented individually and in groups, tests and graduation paper.

The aim of lectures is to ensure the acquisition of the theoretical material of the study course. Hybrid teaching methods are used to achieve the learning outcomes, combining verbal teaching methods, explanatory teaching methods, interactive teaching methods, and demonstrative teaching methods. Various forms of feedback are actively used during lectures, including modern IT solutions such as student survey tools, which also assist in implementing of emotional stimulation and appreciation methods. The materials used during the lectures are uploaded to the e-learning environment and are available to students throughout the entire period of implementation of the study course. During the lectures, the academic staff facilitate discussions which help update the topics covered during the lectures and motivate students to search/discuss possible solutions to the problems.

The aim of the laboratory work is to develop practical skills in the themes of the study courses using the laboratory equipment. In view of the professional focus of the study program, laboratory works are particularly important for the profound mastering of technologies. In laboratory work, the academic staff combine a variety of practical teaching methods, including instructional and productive methods, as well as methods of teaching skills and methods for the use and strengthening of creativity, to achieve the objectives of the study course. When planning laboratory works, the academic staff relates the theme of the task to the IT industry whenever possible, thus allowing students to consider the application opportunities of the mastered theme in the work environment.

The aim of independent and practical work is to strengthen the theoretical knowledge acquired at the lectures by applying it to the analysis and solution of various tasks, situations and problems. To achieve the objectives, the academic staff use similar methods to those used in laboratory work, supplemented by problem-oriented methods and learning discussions, but without the use of laboratory equipment. Autonomous study plays an important role. Independent work is included as a compulsory component in several study course descriptions.

Practical, independent and laboratory work is organized both individually and in groups, ensuring that students develop both their individual skills and the skills essential in the IT industry to work in teams, to formulate and delegate tasks, as well as to present their results.

The purpose of tests is to assess how students have acquired the theoretical knowledge and developed the relevant skills. Depending on the knowledge and skills to be tested, the following forms of assessment are used: assessment tests, test work, examinations and credit tests.

For graduation papers the research method is mainly used, as well as the practical teaching method, the heuristic (discovery) teaching method and the skill-building teaching method. To develop discussion and presentation skills, as well as to discuss and promote the results of the graduation paper, students are offered the opportunity to participate in RTU Student Scientific and Technical Conference.

Students acquire practical and research skills by regularly using literature and internet resources, including international scientific publication databases available in RTU Library with electronic access in ORTUS environment, in order to successfully develop their academic research papers.

Organizational units of RTU, including HR, research, international relations, academic units, as well as the Centre for Academic Excellence, regularly inform staff about the opportunities to improve their competences in the areas of scientific research, methodological and didactic skills, general competences and specific professional activities. ORTUS environment provides information on the scientific activities of academic staff. In order to carry out pedagogical work at a high level, methodological seminars are organized for RTU academic staff on the possibilities of using various teaching methods, share experience and good practice.

The academic staff of the program regularly improve the study curriculum by introducing new, innovative study organization and teaching methods in the study process, the main aim of which is to teach students how to learn, find information, use different sources of information, argue, collaborate with others, make decisions and take responsibility. Cooperation here is both student-student and educator-student oriented. International experience is integrated into the study process.

In addition, individual consultations are provided for the supervision of coursework and projects, internships and Master Thesis. Pre-examination counseling is organized before examinations. If necessary, students can directly contact academic staff outside the tutorial hours by sending their questions in the form of messages or in the appropriate course forum in ORTUS system or by e-mail.

RTU e-learning environment ORTUS based on Moodle platform is actively used to support the study process, which contains study materials, knowledge self-assessment tools, task submission functions, testing functions, as well as video recordings of lectures that are used during the remote studies. The use of the e-learning environment is mandatory for RTU academic staff. The plagiarism detection software developed by IACS is used for the submitted papers. All resources available in the e-learning environment can be used by the student at their own pace and according to their individual needs.

RTU considers all aspects of student-centered education in order to increase students' motivation and improve the quality of their studies.

1. Student involvement in the study process and content development

In accordance with the procedures developed by RTU, students have opportunities to provide regular feedback on the study content. Students are regularly involved in the quality assessment of study programs and participate in the work of decision-making and advisory bodies. In addition to the formal processes, there are regular meetings between students and the head of study program to discuss the content and quality of the studies. There is a semesterly survey in which students give feedback on the study course as a whole. Students also have the opportunity to contact the head of study program or RTU Study Department at any time, where there is a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to software development and other IT processes, and link the outcomes to the study program learning outcomes and the study course volume in terms of credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (document, presentation, video recording, interactive learning materials, etc.). Students have the right to propose their own theme for the graduation paper, thus achieving the learning outcomes in a way that interests them.

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. RTU also regularly uses the opportunity to invite guest lecturers to share their experience with students in the form of individual guest lectures or complete study courses. By meeting guest lecturers in specially organized seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad. Further information on guest lecturers and academic staff mobility is given in section 3.4.1 "Assessment of the compliance of the qualification of the teaching staff members".

4. Social dimension

Students studying in the study program "Computer Systems" have sufficient flexibility to combine work/family life with their studies. This is demonstrated by the fact that most students have already started their working life in the 2nd or 3rd year of their bachelor studies. As a positive fact it should be noted that RTU library is available to students 24 hours a day and also at weekends.

5. Teaching and learning methods

The teaching and learning methods described previously are used in the implementation of the study program and are adapted by the academic staff to the specific situation. Students have the opportunity to receive individual tutorials from the academic staff involved in the study program, including communication in the e-environment using RTU licenses for Zoom and MS Teams platforms, as well as messaging services of the Moodle platform.

6. Learning environment

In 2021, a new FCSIT faculty building was opened on Zunda krastmala 10. Students have access to all the technical equipment needed for modern IT education - computer labs, including virtual computer labs. The new building has quiet working and relaxation areas on each floor. Modern videoconferencing tools such as Zoom and MS Teams licenses for remote lectures and tutorials, as well as other software licenses, including academic ones (e.g., MS Office, and various software development environments and tools) are also available. Classrooms also have the technical equipment to support hybrid learning, thus enabling foreign teachers to be involved in teaching a part of a course/lecture from a distance.

Throughout the implementation of the study program collaboration between librarians and academic staff is ensured, with the aim of improving the teaching and learning process. In the first year of studies, students are introduced to the resources and databases available in the library. Following the modern demand, RTU Scientific Library is digitalizing, offering more and more resources in e-format, including the most important databases of scientific articles in the IT field (IEEE, SpringerLink, ACM, ScienceDirect, Wiley, etc.).

7. Academic staff competence development

The academic staff involved in the study program are provided with regular opportunities to develop their methodological and didactical skills. The competence development process of academic staff includes methodological seminars of the Institute of Applied Computer Systems and the Faculty on the use of teaching and learning methods, including innovative teaching methods, as well as RTU Methodological Conference. The following methodological seminars have been held in recent years:

- 20.02.2019. Academic Integrity and Work with International Students;
- 18.12.2020. Organization of Remote Examinations;
- 12.02.2021. Implementation of Distance Learning;
- 12.03.2021. The Digital Age Student (Zanda Rubene, Professor, University of Latvia);
- 28.01.2022. Academic Integrity at RTU and FCSIT;
- 25.02.2022. Formative Assessment: with and without technology (Anžela Jurāne-Brēmane, Researcher, Vidzeme University of Applied Sciences).

SAM 8.2.2 project provided the opportunity to do internships in IT companies, thus mastering the latest approaches and methods used in the industry in order to integrate them into study courses.

8. Extra-curricular activities for students

A wide range of extra-curricular activities are offered to the students of the study program:

- Students are also involved in scientific work and research on the themes relevant in the field, participating in both local and international projects, which gives them the opportunity to participate in international conferences. As part of the Master Thesis development process, the student most often joins one of the Institute's research fields.

- Each year, a Student Scientific and Technical Conference is organized, where students have the opportunity to gain first-hand experience in publishing their research results.
- Every RTU student is offered opportunities to participate in extra-curricular activities (sports teams, dance groups, choirs, etc.) organized by several RTU departments.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Following mastering of theoretical study courses, students extend and consolidate professional knowledge in practice. The goal of internship is to provide students with practical activity experience required for obtaining professional qualification in IT field at a company or institution, or an IT department of an undertaking beyond RTU.

The volume of internship differs between study program implementation variants. In the first variant of the study program (60 CP), the volume of internship is 6 CP. In the second implementation variant (80 CP), the internship accounts for 26 CP. The study program has two qualifications, which also determine the internship tasks. During the internship, students get acquainted with the company structure and its operation organization, as well as technical and economic indicators of the undertaking. Students are provided with an opportunity to master the latest scientific and innovative technical solutions in the field of software engineering. The internship is organized in the first and second year of studies, in both semesters. The volume of the internships in the second semester is 6 CP for both study program implementation variants. Internship in the third semester, in the volume of 20 CP, is implemented only for the second implementation variant (80 CP). This is related to the fact that students with an academic Bachelor degree are admitted for the second implementation variant.

The internship in the volume of 6 CP, which is anticipated for the study program variant with the volume of 60 CP, is provided in three specializations. The internship (6 CP) in the specialization of design of computer systems (which complies with the qualification of leading system analyst) is intended for obtaining profound knowledge and applying theoretical knowledge for solution of specific tasks to improve practical skills in the profession of system analyst. During the internship, students develop their skills in selecting the system analysis methodology, application of assessment methods for system analysis support tools and resources, planning of requirements elicitation process, as well as draw up technical documentation in conformity with the standards. The internship (6 CP) in the specializations of applied computer system software and applied computer sciences (which comply with the qualification of a leading programming engineer) is devoted to consolidating the obtained theoretical knowledge by students and improving practical skills in the profession of leading programming engineer in relation to software development, introduction and support, including skills of teamwork. During the internship, students improve their practical skills in technology development and application of other tools.

The internship in the volume of 26 CP, which is anticipated for the study program variant with the volume of 80 CP, is provided in three specializations. The internship (26 CP) in the specialization of design of computer systems (which complies with the qualification of a system analyst) is divides into two parts: manufacturing and research internship. The list of internship tasks includes development of skills in selecting the system analysis methodology, application of assessment methods for system analysis support tools and resources, planning of the common notification process regarding requirements, as well as drawing up technical documentation in conformity with the standards. The internship (26 CP) in the specialization of applied computer sciences (which complies with the qualification of a leading programming engineer) is divided into two parts: manufacturing and research internship. The tasks of the manufacturing internship are to develop the workplace configuration, specifying the requirements and software design, coding and debugging skills. The research internship tasks are intended for improving skills in research of new technologies and improvement of existing development approaches. The internship (26 CP) in the specialization of applied computer system software (which complies with the qualification of a leading programming engineer) is divided into two parts: familiarization and qualification internship. The task of the familiarization internship is to familiarize with the company structure and its operation organization, as well as technical and economic indicators of the undertaking and work organization in teams. The tasks of the qualification internship are to develop skills in user interface design and development, algorithm construction and description, program code writing, program debugging, performing unit testing, and drawing up project documents.

Regardless of the seeming similarity of aims and tasks of both variants, the difference is in the complexity of the tasks to be solved. In the second variant of internship (26 CP), the time spent for internship at an undertaking is much longer, which allows students with insufficient practical skills to start with simple work tasks and, towards the end of their internship, be capable of solving tasks of the complexity corresponding to the occupational standards.

In all variants of the internship implementation, students learn how to work in a team. Moreover, the internship manager at the undertaking controls the fulfilment of internship tasks in compliance with the deadlines set in accordance with the requirements of the undertaking and the study program. During the internship, regular consultations with the internship manager at the undertaking and the internship coordinator at the university are anticipated in accordance with instructions of the organizational unit. The internship results are submitted in the form of a report in accordance with the instructions of the organizational unit and are publicly presented at the end of the second semester in the case of internships amounting to 6 CP and at the end of the second and third semesters in the case of internship amounting to 26 CP.

Organization of internship takes place in accordance with RTU Senate Resolution No. 626 adopted on 28 January 2019 “On the Internship Organization Procedure at RTU”.

As mentioned in the Internship Organization Procedure, the internship coordinator at the organizational unit helps provide a place of internship for students. In addition to RTU Senate Resolution, the internship is organized in accordance with the methodological instructions for organizing and implementing the internship for a leading programming engineer profession students of the professional Master study program "Computer Systems" (applied computer sciences and applied computer systems software specializations) and methodological instructions for organizing and implementing the internship for a system analyst profession students of the professional Master study program "Computer Systems" (specialization in computer systems design).

If additional assistance is required with finding a place of internship, it is possible to apply to RTU Career Centre and Student Service, where a career consultant and a project manager help students with searching for and arranging places of internship, as well as promote the development of career management skills with the help of different measures that can ensure successful results in the course of the internship. Once a year, the Career Support and Student Service organize RTU Career Day, within the framework of which students can meet in situ representatives of undertakings and communicate on their future opportunities.

Internship at the already existing workplaces of students is also supported, which is possible in cases when the work tasks of the student at the existing workplace comply with the internship requirements.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

During the reporting period, 77 young professionals graduated from the study program, fully completing the program requirements and elaborating a graduation paper.

Within the professional Master study program “Computer Systems”, students need to develop their Master Thesis including Project in the amount of 26 CP (following changes to the program to be introduced within the framework of the assessment process – in the amount of 20 CP) or in some cases it is also possible to develop Master Thesis including Project in the amount of 20 CP, in the event the student does not obtain a new qualification. Master Thesis including Project comprises both topical technology research and development of a software product or its prototype or performing system analysis for the specific system. Thus, within the framework of their graduation paper, students confirm their skills both in technology-oriented research and in software development and/or system analysis. The Institute of Applied Computer Systems has productive collaboration with the industry enterprises; thus, many students develop their graduation papers on themes defined by undertakings, which are topical for the industry in the current moment. Students may opt to develop a system in line with their interests and in conformity with topical tasks in the modern IT industry. The following studies have been performed for the Master Theses:

- **Information system models and projects**

  Assessment of information systems of an organization, assessment of state information systems, financial system project, company architecture analysis, diversity management, modelling of information flows, information system continuous improvement models, system design;

- **Assessment and analysis of technology and algorithm application**

  Plug-in technologies, web technologies, game development technologies, steganography methods, intellectual agent applications, system division methods, variability management, and different aspects of programming;

- **Data processing and storage**

  Data anonymization, data integration problems, storage of graphic objects, deductive databases, data integration problems, data exchange formats, data visualization technologies, data analytics, cloud computing;

- **Research of safety solutions**

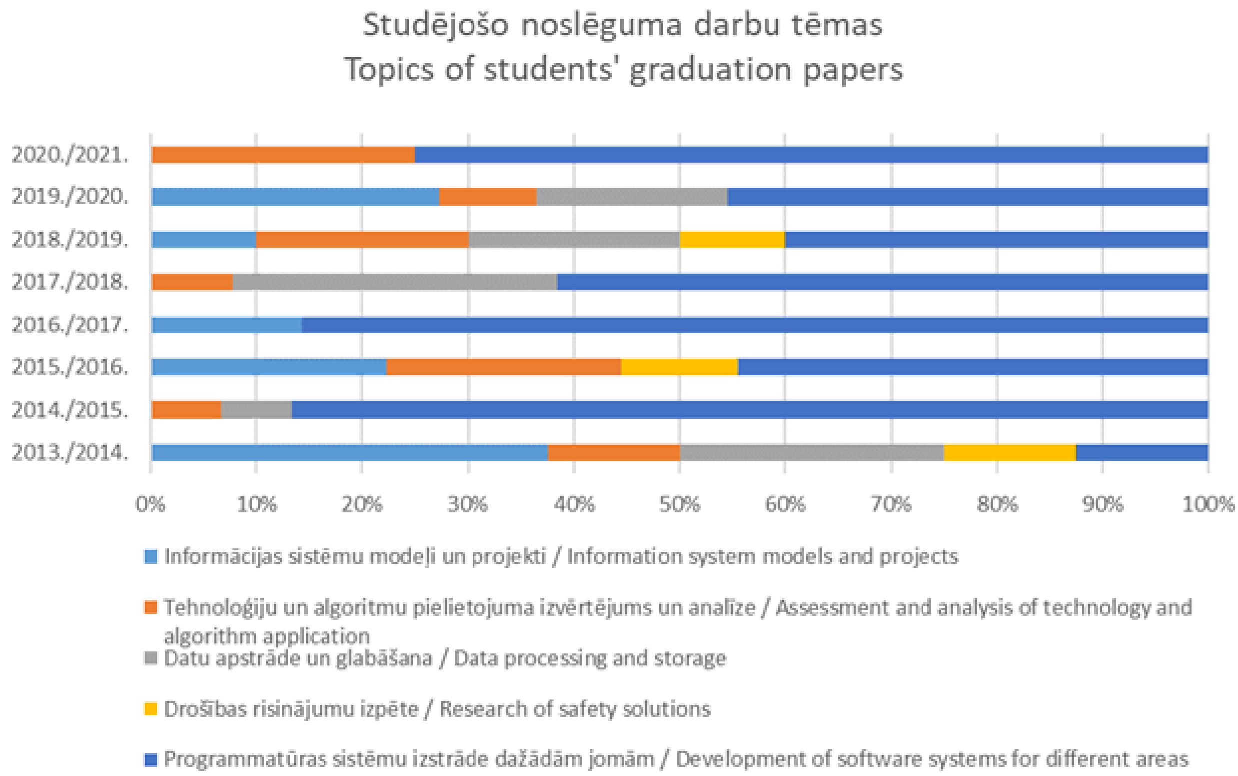
  Operating systems, mobile applications, GDPR introduction.

- **Development of software systems for different areas**

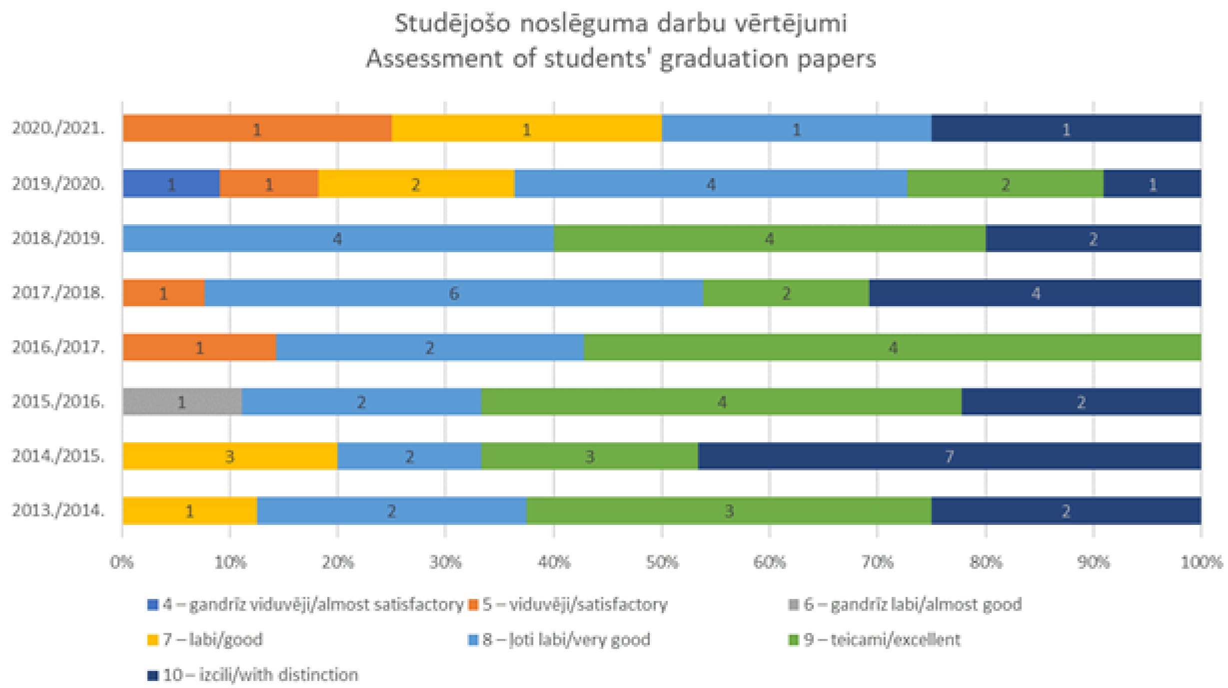
The following software systems have been developed in the project part of the Master Thesis:

accounting systems, workflow and document management systems, financial systems, educational institution work support systems, chat environments, transport, and logistics field systems, website solutions, applications and portals, user support systems, computer games, geolocation-supported systems, personalized systems, 3D scanning.

The overall distribution of graduation papers by theme for each academic year is shown in the figure below. As it can be seen, most graduation papers are written on software systems development for various fields, which is directly related to the professional profile of a programming engineer. Moreover, these areas are in good compliance with IT systems to be developed by Latvian IT enterprises and thus it can be concluded that students in their graduation papers develop systems for similar areas which they later will work on at their workplaces. The general list of themes by year and the grades obtained by students are given in Annex 3.2.6 "Topics of students' graduation papers".



The distribution of students' grades in each year of study is shown in the figure below. As it is seen, high assessments of Master Theses predominate (from very good (8) to with distinction (10)). Most students have received 8 – very good (23 students) and 9 – excellent (22 students). Only in separate cases, students have received a grade of 4-6 (6 students in total). To get the assessment with distinction (10), it is required to approbate the research results by developing a scientific publication. As seen from the figure below, there have been 17 such graduation papers in the reporting period.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The following resources are used for the implementation of the study program:

- Auditoriums for lectures and practical classes. The study program is implemented at the Ķīpsala Campus, which has both FCSIT rooms and RTU joint use premises. The facilities are accessible for persons with disabilities. Available classrooms are described in Part II, Chapter 3, Section 2.3.2 - Resources and Provision of the Study Field.
- RTU information platform ORTUS and E-learning environment, which provide support function for information exchange between the faculty and students, the study process, available study course materials, posted and completed tasks, assessment tests, etc.
- Computer classes and computer labs, which are of particular importance given the specific nature of the program. The necessary software is purchased and installed in the computer labs appropriate for each study course, mostly academic licenses are used for specific software. 5 joint use computer classrooms (140 computers in total) are available at FCSIT and 5 specialized computer labs (150 computers in total) are available at the Institute of Applied Computer Systems. Windows, Linux, MAC and mobile computer classes are available.

Computer labs provide students of the study program “Computer Systems” with equipment necessary for the development of group projects, laboratory works and research during their studies.

- FCSIT joint use computing center, which provides access to computing resources in the cloud. Virtual computer labs are also available for students to use specific software remotely. Licensed Microsoft office software and software development tools are also available to students for learning purposes.
- Virtualization services that allow students to obtain the computing resources they need for various tasks and experiments with the appropriate software and infrastructure, including a fixed internet connection.
- In 2015 FCSIT opened the National Research Centre of Information, Communication and Signal Processing Technologies, where students have the opportunity to join program-relevant research in fundamental and applied research in computer systems development, in particular but not limited to the development of their Master Thesis.
- RTU HPC provides necessary computing power for resource demanding student research, for example, training deep neural networks.
- RTU Scientific Library.

The computer class equipment used in the study programme provides the full performance of laboratory and practical work using the current technical provision. A wide range of operating systems and technical solutions (Microsoft, Linux, Apple products) provides option to observe the operating and processing principles of software in different environments.

Mobile class (Android based devices) gives option to use digital materials and knowledge testing tasks during lecture time (interactive interaction tools that require predesigned configuration and increase the level of reliability of the identity of the task or knowledge test accomplished in the learning process).

IACS virtualization solutions provide option to integrate students' computers into the learning process, using a cloud-based solution available to students with a predesigned configuration that reduces the time for preparing the computer for performing a task.

In the study year 2018/2019, the computer classes and laboratory premises of the Institute of Applied Computer Systems for training and scientific research were occupied for 90% of available time.

RTU Scientific Library has a wide range of books and other resources appropriate for the professional Bachelor study program “Computer Systems” (description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3.). Upon request of the administration of the study program “Computer Systems”, 295 new books have been purchased in the period 2013-2021 for the amount of EUR 16,024.64.

Part II, Chapter 3, Section 2.3.3 lists the e-resource collections available in RTU Scientific Library. The content of the following collections is most relevant to the specific nature of the study program Computer Systems: ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost Web, ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate), learning materials repository Merlot, Latvian Standards Database (available only in the library premises). There is also an interlibrary loan and resource sharing system, ExLibris, where students can order books and journals that are available in other libraries.

Wireless Internet connection is available to students in all RTU premises, which enables students to study additional materials, participate in various interactive activities during the lectures, such as polls. The Institute of Applied Computer Systems also has the necessary equipment and software licenses for remote work with students, as well as the possibility to provide hybrid work, where some students are in the lecture room and some connect to the lecture remotely.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

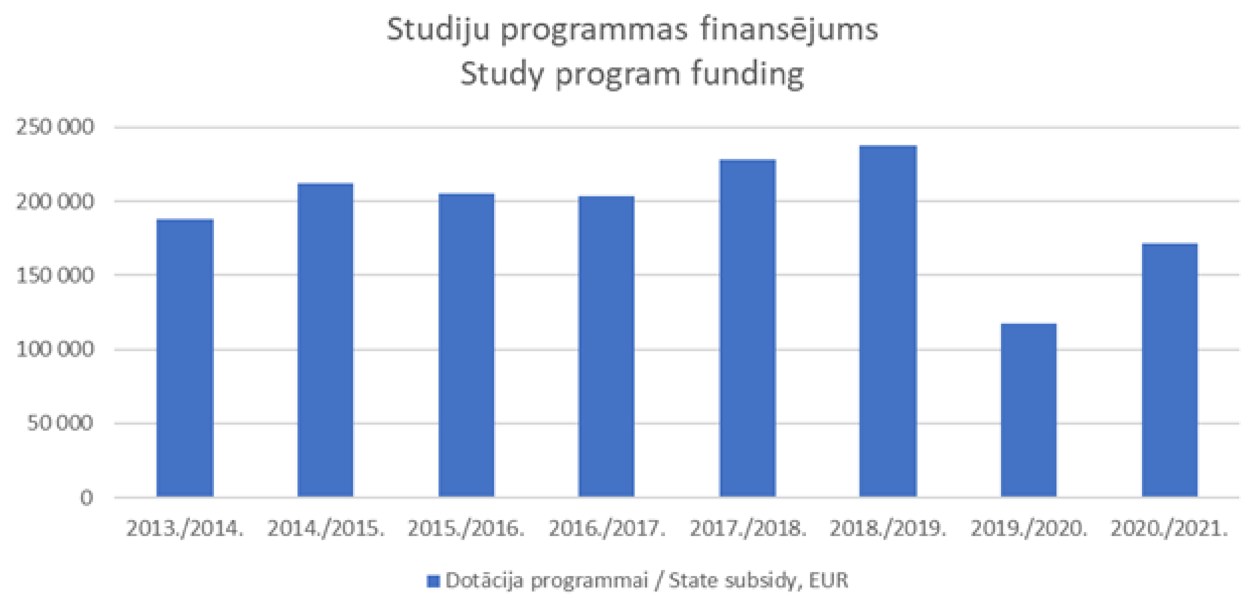
3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and facilities meet the conditions for the implementation of the study program and contribute to the achievement of the learning outcomes. The professional Master study program "Computer Systems" is implemented as a state budget financed study program with 24 state budget funded seats.

The data on funding are presented in the table below:

Study Program Funding

Academic year	State subsidy, EUR	Local student tuition fees, EUR	Total study program funding, EUR	Funding of one state budget funded seat, EUR
2013/2014	187 990	0	187 990	5 799
2014/2015	211 990	0	211 990	5 799
2015/2016	205 001	0	205 001	5 799
2016/2017	203 161	0	203 161	5 799
2017/2018	228 244	0	228 244	6 061
2018/2019	237 809	0	237 809	6 345
2019/2020	117 419	0	117 419	6 608
2020/2021	171 701	0	171 701	6 694



As shown in the table and the figure above, the professional Master study program "Computer Systems" had a rapid reduction of financing in 2019/2020 academic year due to the reduction in the number of students.

Based on the 2015 "Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation", as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study program, RTU has determined that the professional Master study program must have at least 19 students in each academic year. During the reporting period, there were on average 32 first-year students and 21 second-year students each year.

Information on the breakdown of funding between cost items is provided in the Annex "Breakdown of funding between cost items" of the Self-Assessment Report. Information on the cost per student is given in the Annex "Breakdown of funding between cost items". Information on the minimum number of students required for the study program is given in the Annex to the Self-Assessment Report "Minimum number of students to ensure the cost-effectiveness of the study program".

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study program comply with the conditions for the implementation of the study program and the requirements of the regulatory enactments. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The responsible instructor is appointed by the head of the responsible structural unit. Instructors responsible for study courses can be professors, associate professors and assistant professors with a scientific degree in the relevant branch or sub-branch of science. The instructor responsible for the special study courses of professional study programmes can also be assistant professors without a scientific degree and lecturers with appropriate and sufficient practical work experience for the relevant study course. The study courses of these responsible instructors cannot be used in academical study programs. All responsible instructors involved in the implementation of the study program “Computer Systems” hold a PhD degree and each is an expert in their research field, which is attested by the scientific publications they published and research projects they implemented. In total, 83% of the academic staff involved in the implementation of the study program hold a PhD degree. In some cases, industry professionals with the necessary practical experience are involved, as well as assistants and laboratory assistants having no PhD degree have been involved in the organization of laboratory and practical works. In total, 29 academic staff members are involved in the implementation of the study program.

Elected academic staff participate in the implementation of the study program, the election of which and the observance of the necessary quality requirements are regulated by the RTU Regulations No. 589 adopted on April 27 2015 “Regulations on the Procedure for Election of Docents, Lecturers and Assistants” and No 649 adopted on April 26 2021 “Regulations on the Procedure for Election of Professors or Associate Professors and Qualification Assessment of Professors and Associate Professors”, as well as the Rector's order on the procedure for evaluating the performance of professors and associate professors (No. 01000-1.1-e / 157 of 7 October 2021).

The number of academic staff involved in the implementation of the study program is 29; the number of guest teaching staff is 4 (total during the reporting period).

Summary on the involvement of the guest lecturers in program implementation:

Name, surname of the guest lecturer	Organization	Date	Study course, activity	Contact hours
Vladimirs Kotovs	AS Citadele banka	2015 - 2022	Technological Devices for Software Development, delivering lectures and laboratory works	64
Ansis Ataols Bērziņš	UL Faculty of Physics, Mathematics and Optometry	2020/2021	User Adaptive Interface Software (study project), delivering lectures and laboratory works	48
Mārtiņš Leitass	Emergn	2014/2015	Programming in Computer Network Environment, delivering lectures and laboratory works	32

Ēriks Dobelis	CISA, CISM; Member of the Cyber Defense Division of the National Guard of the Republic of Latvia, business coach	2017/2018 2018/2019 2019/2020 2020/2021 2021/2022	Lecture “Information System Audit” for the course “Analysis of Software Risks”	3 (each year)

To ensure and improve the quality of studies, the academic staff involved in the implementation of the study program regularly improve their academic and professional knowledge at methodological seminars, conferences (national and international), as well as in scientific and research work, participate in various scientific and methodological projects. Training and qualification improvement are carried out through the participation of academic staff in conferences and seminars, studying in various courses, participation in the work of other organizations, practical work as experts and consultants. RTU provides access to edX and Coursera study courses in the areas of interest to the academic staff. RTU organizes an annual methodological conference, which is regularly attended by the academic staff of the Institute of Applied Computer Systems as listeners and presenters.

A particular highlight is the *Buffalo Program* launched in 2019, which brings academic staff members to the State University of New York at Buffalo, USA for a semester-long internship. Currently, an academic staff members of academic Master study program “Computer Systems” Professor Marina Uhanova has completed the internship process. The academic staff members involved in the implementation of the study program also have an opportunity to undertake internship in Latvian IT companies within the SAM 8.2.2 project.

The compliance of academic staff with the requirements for the implementation of study courses is confirmed by the data included in the CVs of academic staff and their research results (scientific projects, publications, presentations at scientific conferences, as well as contractual work). In accordance with the Law on Higher Education Institutions, academic staff also carry out research activities in the relevant field alongside their academic activities. Academic staff are free to choose their field of research and to propose appropriate topics for graduation papers. Within the 2021 International Evaluation of Scientific Institution Activity, RTU Faculty of Computer Science and Information Technology was awarded a four-grade rating.

Brief summaries of the academic staff activities are given below.

Assoc. prof. Egons Lavendelis

Head of the study program “Computer Systems”. Research in artificial intelligence, focusing on multi-agent systems, software for control of multi-robot systems based on intelligent agents and systems theory. E. Lavendelis has 42 publications in the corresponding field of research (14 of them in the last 6 years) and has participated in 18 research projects (7 of them in the last 6 years), including FP7 and ERA-NET international projects, and has been a scientific leader or RTU research team leader in 3 projects.

Prof. Mārīte Kirikova

Scientific interests are mostly related to requirements engineering. Research focuses on models for reflecting information system context and developing continuous requirements engineering frame to ensure elasticity for the requirements engineering process. The latest studies are related to inclusion of data analytics in the requirements engineering process. During the last six years, she participated in 4 international and 5 local projects. Research results of the past six years are reflected in over 75 publications.

Prof. Oksana Ņikiforova

Long-term academic work experience delivering the study course "Object-Oriented Systems Analysis" and industrial experience in the position of a systems analyst and product owner allowed Oksana Ņikiforova to develop the necessary competences to teach object-oriented systems analysis. Many years of experience in the management of research projects, student-initiated software development projects and industrial product development projects and participation in their implementation provide competence to participate in the implementation of the course "Object-Oriented Programming Practice (study project)". The author of more than 100 scientific articles, has participated in more than 30 scientific projects.

Assoc. Prof. Ērika Nazaruka

Her scientific publications are related to the formalization of the software development process. Formalization tools allow reducing certain risks associated with project development by implementing quality management activities at all stages of development. Her research interests are focused on research into development of model-driven software design (more than 70 articles). In order to improve the qualification in security issues, she undertook the course "Palo Alto Networks Online Instructor Faculty Training" organized by Palo Alto Networks – Cybersecurity Academy and obtained the Palo Alto Networks Cybersecurity Academy Instructor.

Prof. Marina Uhanova

In the last six years, she has published 12 scientific articles and participated in one scientific project related to the study courses she implements (software development and testing). In 2019, she completed an internship at the the State University of New York at Buffalo, USA for the purpose of professional advancement, and mastered three Coursera courses: "Text Retrieval and Search Engines", "Programming for Everybody (Getting Started with Python)" and "Python Data Structures".

Assoc. Prof. Pāvels Rusakovs

In the last six years, he has published three scientific articles dealing with some of the problems of the Semantic World Wide Web and the use of video steganography for copyright protection.

Assist. Prof. Ilze Birzniece

She has enhanced her competences in data analysis and knowledge extraction over the last two years by working on three ITCC projects and by supervising students' graduation papers dedicated to the topics of the delivered course. In the last six years, 10 articles have been published, 7 of them related to information retrieval, data mining and analytics in different application domains. In 2021, completed the RTU professional advancement program "Data Analysis and Reporting with Python" in the volume of 160 hours.

Assoc. Prof. Gundars Alksnis

His experience and competence in using programming languages C# and .NET, participating in the implementation of the professional Bachelor study course "Visual Programming Fundamentals (study project)" and professional Master study course "Visual Programming (study project)" since 2010 help develop student competences in visual programming making programming more efficient. Programming experience in visual programming was gained from the previous work in the

IT industry.

Assoc. Prof. Gints Jēkabsons

He is involved in the research related to the topics of the study courses he implements - machine learning, statistics, optimization, information retrieval. In the last six years, he has published seven scientific articles in the context of these topics and has participated in two research projects. He regularly participates in professional advancement seminars.

Assoc. Prof. Aleksejs Jurenoks

During the last six years, he developed and published 18 scientific articles. Participated in three international projects and one national research project. Upgraded his qualification at Aristotle University of Thessaloniki in Greece, Malaysian Institute of Information Technology in Malaysia, Technical Military Academy of Bucharest in Romania, and National University of Singapore in Singapore. Since 2006, he has been delivering different courses in computer science at several Bachelor and Master level study programs of RTU, and supervises Master and Bachelor Theses. Scientific research activity is related to the development of methods for extending the service life of wireless sensor networks. Participated in different workgroups for developing the occupational standards; member of international conference organization and program committees.

Assist. Prof. Imants Gorbāns

During the last six years, he developed and published 3 scientific articles and participated in 2 scientific projects.

Assoc. Prof. Natālija Prokofjeva

Conducts research in student knowledge assessment and e-training personalization. Participated in pedagogical qualification upgrade courses “New Product Creation and Development Module Training Methods” and “Conflict Situation Solution Skills”. During the last six years, she published 24 scientific articles devoted to the study process improvement issues.

Assist. Prof. Ilze Andersone

She has supplemented her knowledge in the field of intellectual system development in the last three years by participating in several ITKC projects (in cooperation with Mobilly, HELMES, Computer Science Centre). During the last six years, she published seven scientific articles on applications of artificial intelligence (AI) models in data analysis and AI robotics applications. Three more articles on AI applications in data analysis have been accepted for publishing.

Assist. Prof. Jānis Eiduks

During the last six years, he developed and published 5 scientific articles.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

One of the challenges that had to be addressed during the reporting period has been to renew the academic staff, which has been achieved by replacing retiring colleagues with new qualified academic staff. At the start of academic year 2016/2017, the average age of the elected academic staff of the Institute of Applied Computer Systems was 49.8 years, while at the start of the academic year 2021/2022 it was already 47.7 years. However, the overall structure of the academic staff during the reporting period is considered to be stable.

Generally, young colleagues start their career at the Institute of Applied Computer Systems already during their studies (final semesters of Bachelor studies or Master studies) by getting involved in one of the research projects implemented at the Institute. Students who perform well during their studies are offered the opportunity to continue their studies in the PhD program and to get involved in the teaching process, initially as assistants, and later during their PhD studies as full-fledged lecturers for undergraduate students. This mechanism of attracting new academic staff has proven to be very useful in terms of assessing potential candidates during their studies and reaching out to students with the qualities and skills required for academic work.

Currently, 18 of the 26 elected academic staff members at the Institute of Applied Computer Systems hold PhD degree, representing ~70% of the elected academic staff.

The field-specific study courses are mostly implemented by the academic staff of the departments within the Institute of Applied Computer Systems, whose composition has undergone relatively little change. The changes have been made with one of two objectives:

1. to change the academic staff of a study course in order to improve or modernize the content of the study course. Such changes are based on student feedback and evaluation of the course content.
2. to change the academic staff of a study course who is temporarily or permanently unavailable for the implementation of a particular study course for any reason due to retirement, change of job, or other reason.

Regardless of the reason for the replacement, it is taken into account that the quality of the implementation of the study course must not be reduced by the arrival of new academic staff. This ensures the quality of the implementation of the entire study program.

At the Department of Artificial Intelligence and Systems Engineering (at the beginning of the reporting period referred to as the Department of Systems Theory and Design):

- Instead of professor Agris Ņikitenko, the study course “Methods of Intelligent Systems Design (study project)” is implemented by Assist. Professor Ilze Andersone. No significant changes in student feedback have been observed.
- Assoc. Professor Egons Lavendelis has taken over the implementation of the study course “Master Thesis Including Project” and internships from the former head of the study program Professor Jānis Grundspeņķis. No significant changes in student feedback have been observed.

At the Department of Software Engineering:

- Instead of Professor Larisa Zaiceva, the study course “Software Metrology and Planning Models” is implemented by Assoc. Professor Aleksejs Jurenoks. No significant changes in student feedback have been observed.
- Instead of Professor Larisa Zaiceva, the study course “Programming in Computer Networks” is implemented by Professor Marina Uhanova. The new skills and competences acquired by Marina Uhanova were used, which were acquired during the participation in so-called "Buffalo" program, which provides academic staff training at the University of Buffalo, USA. No significant changes in student feedback have been observed.
- Professor Marina Uhanova replaced Assoc. Prof. Eleonora Latiševa as a responsible instructor at the study course “Operating Systems of Computer Networks”, Assist. Professor Imants Gorbāns is also involved in the course implementation. No significant changes in student feedback have been observed.

- Professor Marina Uhanova replaced Assoc. Professor Eleonora Latiševa as a responsible instructor at the study course “Information Security and Protection”. No significant changes in student feedback have been observed.
- Instead of Professor Larisa Zaiceva, the study course “Technological Tools for Software Development” is delivered by Professor Marina Uhanova. No significant changes in student feedback have been observed.
- The study courses “Introduction to Computer Aided Solution Processing” and “Software of User Adaptive Interface” are delivered by Professor Gints Jēkabsons and Assoc. Professor Aleksejs Jurenoks, respectively, instead of Professor Jurijs Lavendelis. No significant changes in student feedback have been observed.
- The study course “Applied Intelligent Systems” is delivered by Assoc. Professor Aleksejs Jurenoks, instead of Professor Leonīds Novickis. No significant changes in student feedback have been observed.

At the Department of Applied Computer Science:

- Instead of Professor Uldis Sukovskis, the study courses “Master Thesis Including Project” and “Software Risk Analysis” are delivered by Professor Pāvels Rusakovs and Assoc. Professor Ērika Nazaruka, respectively. No significant changes in student feedback have been observed.
- Instead of Professor Gundars Alksnis, the study course “Visual Programming” is delivered by Assist. Professor Gusts Linkevičs. No significant changes in student feedback have been observed.

Study courses in humanities are provided by other organizational units of RTU:

- The organization of the study course “Presentation Skills” has been overtaken by Professor Airisa Šteinberga from Assistant Professor Zanda Lejniece.
- The organization of the study courses “Business Sociology” and “Industrial Relations” has been overtaken by Professor Laila Girsova from Assist. Professor Valērijs Kuņickis.
- The organization of the study course “Pedagogy” has been overtaken by Professor Alīda Zigmunde from Professor Anita Lanka.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

At the same time, rigorous quality control is applied to the implementation of the study courses. The primary source of information is student feedback. Trust-based cooperation with the student self-government has been established so that students can approach not only the head of the study program but also their peers in the student self-government, who in their turn inform the head of the study program. All student complaints are promptly assessed and discussed with the academic staff. If it is found that the academic staff is unsuitable to implement the study course in question, new academic staff members are sought.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field

of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

When defining the curriculum of a study course, the responsible instructor, in collaboration with the head of the study program, assesses the role of the study course in the study program, considering the required background knowledge and providing the necessary foundations for the subsequent courses. All changes in the study program, as well as significant changes in the study courses, are discussed in the Council of the Institute of Applied Computer Systems, which is composed of the heads and representatives of all departments within the Institute. Representatives of each organizational unit consider proposed changes from the perspective of their unit's courses. As soon as a link between study courses is identified, a working group is set up, involving the head of the study program, the responsible instructors of all the courses involved and, where appropriate, the heads of the departments implementing the courses. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The result is that the responsible instructors of all study courses are informed about the curriculum and expected learning outcomes of thematically related study courses, thus avoiding overlapping between the study courses and also the omission of important topics from any of the courses in a given field. Changes to the general part of the study program, which does not comprise field-specific study courses, are discussed with the heads of the departments or responsible instructors of the study courses concerned. The academic staff involved in the study program implementation are informed about the role of their study courses in mastering skills and competencies defined in the occupational standards of a leading programming engineer and system analyst. Any changes in the study program are also assessed with regards to the content of both these standards to ensure opportunities for students to obtain these qualifications, having completed specialization of the respective programs.

In order to get a precise idea of the curriculum, teaching methods and terminology used in colleagues' courses, it is possible to attend their lectures. In order to ensure quality, the study courses are peer observed by another lecturer, thus taking over the good practices and providing feedback to the study course implementer. Open lectures are also organized for the academic staff. Methodological seminars are regularly organized at both Institute of Applied Computer Systems and the Faculty level, where academic staff share their positive experience, which helps all academic staff to cope with new challenges. One of the situations, when this was particularly relevant, was the transition to remote studies at the beginning of the COVID-19 pandemic. In addition to the new circumstances, academic staff also share their experience on other issues such as students' academic integrity, graduation papers, conflict resolution, changes in the approaches of today's young people to their studies, work with the employed students, etc.

In response to the changes in the procedures, official documents, and organization of studies the most appropriate approach to the nature of the change is chosen, for example by organizing an information seminar or sending out detailed information about the changes and who to contact for further information.

In general, new academic staff start their academic career at the Institute of Applied Computer Systems by supervising practical and laboratory work or assisting at the lectures. Initially, new academic staff work under the guidance of experienced colleagues, meeting regularly with the responsible instructors to coordinate the content of the classes and the teaching methods to be used, thus ensuring knowledge transfer between the academic staff involved in the implementation of the study program. Having obtained experience and PhD degree, young academic staff are also involved in the work with Master students.

The head of the study program monitors the implementation of the program and the cooperation between the academic staff. One of the tools for identifying problems is student survey that is conducted every semester. If students point out deficiencies in this survey, the head of the study program organizes a meeting between all the academic staff involved with the aim of finding a solution to the problem.

The study program is implemented by 24 academic staff members who hold a PhD degree, including 7 professors and 9 associate professors. The number of students per academic staff in the study program is 2.11.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DGD0(47526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DGD0(47526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DGD0(47526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DGD0(47526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DGD0(47526)_CompliancewiththeStateEducationStandard_ProfMag_ENG.pdf	P06_3.2.1_DGD0(47526)_AtbilstibaValstsStandartam_ProfMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_DGD0(47526)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf	P07_3.2.1_DGD0(47526)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DGD0(47526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DGD0(47526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DGD0(47526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DGD0(47526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DGD0(47526)_StudyCoursesdescr_ENG.zip	P10_DGD0(47526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_DGD0(47526)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_DGD0(47526)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Telecommunication Technologies and Networks Management (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Telecommunication Technologies and Networks Management*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Vjačeslavs*
Surname of the study programme director	*Bobrovs*
E-mail of the study programme director	*Vjaceslavs.Bobrovs@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*+37127896246*
Goal of the study programme	*The aim of the study programme is to prepare specialists who are characterized by the ability to think systematically, analyse, develop and implement engineering solutions, as well as manage telecommunication systems. In addition, to develop students' ability to perform scientific work, participate in local and international projects and continue Doctoral studies. Students are provided with in-depth academic, practical and professional knowledge in the fields of telecommunications management, fibre optics and wireless transmission, and information technology.*
Tasks of the study programme	*- to provide competitive education in the telecommunication technologies and networks management sub-sector in accordance with the level of master's studies and international standards; - to develop students' systemic thinking and practical skills required in the field of telecommunications management and development and implementation of engineering solutions; - in the study process to promote students' independent and practical work in groups; - to ensure sufficient flexibility of the content of the study program, the realization of the study process, development and changes of scientific research work, in accordance with the changing requirements of the labour market and changes in telecommunication technologies, international practice, and science; - to develop cooperation with similar or thematically related study programs in other countries within the framework of ERASMUS+ and other agreements; - to inform and stimulate the desire of students to participate in the implementation of scientific research; - to prepare and motivate students for further Doctoral studies; - to ensure the achievement of the learning outcomes of the study programme.*

Results of the study programme	*- is able to independently formulate and analyse scientific and professional problems in the telecommunication technologies and networks management sector; - is able to manage telecommunication networks and understands their processes; - is able to conduct scientific research, formulate and substantiate its results; - is able to adapt and learn new research methods and technologies; - is able to professionally design, submit and present the results of scientific research; - is able to participate in research projects and assist in pedagogical work; - is able to prepare scientific articles and conference presentations; - is able to apply current methods and tools in telecommunication system management, analysis and modelling tasks and solutions; - is able to organize and lead a technologies' developer working groups, delegate work tasks, control their execution, and analyse the results; - is able to independently improve their competencies; - is able to innovate in the telecommunications sector.*
Final examination upon the completion of the study programme	*The acquisition of the programme concludes with a final exam, which includes the development of an independent Master thesis and public defence in an open session.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree of Engineering Science in Telecommunication Engineering or a comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Telecommunication Technologies and Networks Management*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*

Admission requirements (in English)	*Bachelor Degree of Engineering Science in Telecommunication Engineering, or a comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Telecommunication Technologies and Networks Management*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The master academic study programme “Telecommunication Technologies and Networks Management” has been implemented for more than 25 years. The programme is licensed on 03.04.2007. (licence No 04051-107).

The volume of the study programme is 80 credit points (CP) or 120 credit points according to the European Credit Transfer and Accumulation System (ECTS). The type of implementation is full-time intramural studies (2 years). The full-time study programmes are implemented in the standard planning of Riga Technical University (RTU) in each study year there are 2 semesters, length of each semester is 20 weeks - 16 study weeks and 4 session weeks. To start studies academic or professional bachelor's degree in engineering sciences is necessary. The place of implementation of the study programme - Riga. The study programme is implemented in Latvian and English languages.

In the reporting period, significant changes in the programme have been done in order to improve the study programme and to provide students in a more complete way with the newest knowledge and the necessary skills in telecommunication technology and with the competencies in the profession.

There are following substantial changes to the study programme parameters since the issuance of the previous accreditation form of the study field:

1. the new director of the study programme professor Vjačeslavs Bobrovs. V. Bobrovs has the corresponding qualification and experience in elaboration of the content of higher academic education study programme;
2. the volume of the study programme is decreased from 82 CP to 80 CP;
3. title of the academic study programme is changed from “Telecommunication” to “Telecommunication Technologies and Network Management”;
4. the educational classification code of the study program was changed to 43526 – "Other engineering sciences";
5. the degree to be obtained has been changed to "Master Degree of Engineering Science in Telecommunication Technologies and Networks Management";
6. admission requirements have been changed from “Bachelor Degree of Engineering in Electrical Engineering or a comparable education” to “Bachelor Degree of Engineering Science in Telecommunication Engineering or a comparable education”;
7. the volume of the compulsory part (A) is decreased from 40 CP to 34 CP;
    - such courses were excluded from the compulsory part (A): DMS436 Mathematical Statistics – 3CP, RDE418 Telecommunications Theory (special course) – 4 CP, RAE475 Telecommunications and Computer Networks – 5 CP, RAE555 Teletraffic Theory – 3 CP, IDA117 Basics of Occupational Safety – 1 CP;
    - such courses are included in the compulsory part (A): RDE701 Telecommunications

Theory (special course) – 5 CP, RDE703 Microwave Telecommunications Systems – 5 CP;

8. the volume of the compulsory elective part (B) is increased from 18 CP to 22 CP, and the volume of the compulsory elective professional specialisation (B1) part – from 14 CP to 18 CP;
   - the following study courses are excluded from the compulsory elective professional specialisation (B1) part: RAE533 Telecommunications System Engineering – 3 CP, RDE416 Microwave Telecommunications Systems – 4 CP, RAE554 Telecommunications Networks Design Theory – 3 CP, RAE428 Management in Telecommunications Area – 2 CP, RAE454 Power supply for telecommunications devices – 3 CP;
   - the following study courses are included in the compulsory elective professional specialisation (B1) part: RAE475 Telecommunications and Computer Networks – 5 CP, RAE555 Teletraffic Theory – 3 CP, RDE713 Digital Optical Communication Systems – 4 CP, RDE714 Quantum Communication – 6 CP, RDE715 Metaphotonics in Telecommunications – 4 CP, RDE716 Microwave Photonics Devices and Systems – 6 CP, RDE717 Hybrid Optical Fibre-Wireless Communication and Networking – 4 CP, RDE718 – Basics of Integrated Photonics – 4 CP, RAE713 Management of Telecommunications Projects – 4 CP, RAE714 Telecommunications Network Management – 6 CP;
   - the following study courses are excluded from the humanitarian and social (B2) part: IUE452 Business Economics – 4CP, IRO578 Organization and Planning of Production. Management or Enterprise – 4 CP;
   - the following study course is included in the humanitarian and social (B2) part: IVZ845 Enterprise Management – 4 CP.

The name of the master's study program "Telecommunications" was applied in the previous century in the nineties. In thirty years, a series of technological solutions for ensuring communication have appeared in the world. Currently, the most common technologies are low-frequency and high-frequency wireless solutions, as well as closed and open optical communication systems. People use solutions of this type on a daily basis. It is expected that in the future, quantum communication technologies will also reach the engineering level. Therefore, the concretization of the name of the study program, where reflects the modern word "technology" and also defines what the graduates of the master's study program will do - create technologically complex solutions and plan the infrastructure of the communication system and their development, and this is "network management".

The study program classification code 43526 – "Other engineering sciences" has been chosen because the name, purpose, content and awarded the degree of the program are related to telecommunications technology and network management, which includes complex electrical communication technological solutions, which by its nature correspond to several engineering sciences. The new obtainable degree "Master of Engineering in Telecommunications Technologies and Network Management" is more in line with the skills acquired during studies in the "Telecommunications Technologies and Network Management" program and gives a comprehensive picture of the Master's student's specialization, since the electronics industry does not include complex electrical communication technological solutions and according to Cabinet of Minister's regulations No. 322 "Regulations on Latvian Education Classification" classification code 523 "Electronics and Automation" and the degree to be obtained "Master Degree of Engineering in Electronics and Automation" do not match.

The made changes are connected with improvement of the study process and the quality, taking into account the recommendations from enterprises and associations of the field, as well as technology development tendencies in order to provide modern learning according to the requirements of the field.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The academic master's study programme „Telecommunication Technologies and Network Management” is elaborated in accordance with the Law on Higher Education Institutions of the Republic of Latvia and in accordance with the Classification of Education of the Republic of Latvia.

For implementation and development of the study programme over the course of time, principles of Latvian classification infrastructure (LKI) and European classification infrastructure (EKI) are observed.

The study programme is developed taking into account RTU strategic objectives, market offers and potential demands.

The study programme is elaborated according to the RTU strategy and the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”. Acquisition of knowledge and skills anticipated in the study programme is provided by the academic staff and scientists of the European level, who are involved in professional state and international level expertise’s on regular bases as well as have high qualifications with many years of experience. During the implementation of the study programme, innovative study methods are used -the use of more practical and modern technologies.

The study program is included in the study direction “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which is characterized by a set of study programs whose main focus is on the use of technology and scientific knowledge specific to the direction in the study process.
The study program directly corresponds to the study direction "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", as the content of the study program focuses on telecommunications technologies and network management, including knowledge and skills corresponding to information technologies, electronics, telecommunications and partly also for computer science.
In recent years, a series of technological solutions for ensuring communications have appeared in the world. Currently, the most common technologies are low-frequency and high-frequency wireless solutions, as well as closed and open optical communication systems. Therefore, the concretization of the name of the study program, where reflects the modern word "technology", and also defines what the graduates of the master's study program will do - create technologically complex solutions and plan the infrastructure of the communication system and their development, and this is "network management". The study program classification code 43526 – "Other Engineering Sciences" has been chosen because the name, purpose, content and awarded degree of the program are related to telecommunications technology and network management, which includes complex electrical communication technological solutions, which by its nature correspond to several engineering sciences. Graduates of the program are awarded the "Master Degree of Engineering Science in Telecommunication Technologies and Networks Management".
The full scope of the study program is 80 CP and the duration of implementation is 2 years. The

duration and scope of the program implementation allow for covering the skills and knowledge defined in the study program.

The objective of the study programme is to prepare experts, who are able to think systematically, analyse, develop, and introduce new engineering technical solutions we well as manage telecommunication technologies and networks thereof. In addition, to develop the ability of students to perform scientific work, participate in local and international projects and continue studies in the doctoral study programme.

Within the framework of the study programme students are provided deeper academic, practical and professional knowledge in the fields of telecommunication management, fibre optics and wireless transmissions and information technologies. Also, to provide knowledge, skills and competencies according to level 7 of the qualification infrastructure of Latvia.

The process of enrolment for master's studies is regulated by the regulations approved by the RTU Senate "Requirements for the foreign students for enrolment in the study programs and parts of the study programs attached to RTU international cooperation and foreign students department in 2021".

The strategical objective within the framework of the existing RTU strategy is to provide internationally competitive higher-quality scientific research, higher education, and technology transmission in the field of telecommunications by formulating strategical tasks of the faculty - qualitative study process, excellent research, sustainable commercialisation/valorization.

Tasks of the study programme:

- to provide competitive education in the telecommunication technologies and networks management subsector in accordance with the level of master's studies and international standards;
- to develop students' systemic thinking and practical skills required in the field of telecommunications management and development and implementation of engineering solutions;
- in the study process to promote students' independent and practical work in groups;
- to ensure sufficient flexibility of the content of the study program, the realization of the study process, development and changes of scientific research work, in accordance with the changing requirements of the labour market and changes in telecommunication technologies, international practice, and science;
- to develop cooperation with similar or thematically related study programs in other countries within the framework of ERASMUS+ and other agreements;
- to inform and stimulate the desire of students to participate in the implementation of scientific research;
- to prepare and motivate students for further Doctoral studies;
- to ensure the achievement of the learning outcomes of the study programme.

After the acquisition of the study programme the graduate (**planned achievable results**):

- is able to independently formulate and analyse scientific and professional problems in the telecommunication technologies and networks management sector;
- is able to manage telecommunication networks and understands their processes;
- is able to conduct scientific research, formulate and substantiate its results;
- is able to adapt and learn new research methods and technologies;
- is able to professionally design, submit and present the results of scientific research;
- is able to participate in research projects and assist in pedagogical work;
- is able to prepare scientific articles and conference presentations;

- is able to apply current methods and tools in telecommunication system management, analysis and modelling tasks and solutions;
- is able to organize and lead a technologies' developer working groups, delegate work tasks, control their execution, and analyse the results;
- is able to independently improve their competencies;
- is able to innovate in the telecommunications sector.

Measurements of the study programme results are reflected in study results of students, employment of the graduates, feedback from employers, enhancement of international cooperation, increase of the number of projects, increase of the number of students involved in the research process, the approbation of the research results.

The title of the study programme, the obtained degree, objectives, tasks and achievable results are mutually linked and the reach thereof is very high.

Applicants with a Bachelor's Degree of Engineering Science in Telecommunication Engineering or a comparable education are admitted to the programme.

Graduates of the study programme will obtain a Master's Degree of Engineering Science in Telecommunication Technologies and Networks Management.

After the acquisition of the degree, it is possible to continue education in doctoral studies.

The programme with its activity promotes the keynote defined in the RTU Strategy for 2021 – 2025: "High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities in the Baltic and Nordic region, which is acting based on a study system built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies", and implements it in real life.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The field of telecommunications in Latvia and the world in the last years develops very fast, and the quality of the electrical communication infrastructure is at a high level. Indicators of the field do increase and in the future synergy of the field of telecommunications with economics and other national economy fields will be important. The economic and/or social justification of the study programme is based on the research performed in the field and the employment of the graduates.

Employment of the graduates is an important indicator, which shows the need for specialists prepared in the study programme at the labour market. Employment of the graduates of the study programme "Telecommunication Technologies and Network Management" is high and the surveyed graduates make their career in the profession obtained. Most graduates work in telecommunication enterprises, IT companies, higher schools, scientific research institutions, and industrial fields in Latvia and abroad. A large part of employers proposes work offers already during studies. In the period from the study year 2013/2014 until the study year, 2021/2022 about 95% of the graduates work in parallel with their studies. The study programme graduates can become directors, senior experts, engineers, planners in telecommunication and ICT enterprises, data transmission infrastructure specialists, telecommunication system analysis specialists, telecommunication technologies and solutions development and introduction specialists, and competent scientists.

The knowledge acquired during the studies allows establish own enterprises, take leading positions in private enterprises or state institutions, as well as lead high-level engineering projects in the callable modern technology fields.

Surveys of graduates provide recommendations for improvement of the study programme:

- Study course rotation by semesters;
- To increase the number of guest lecturers for implementation of the study courses, who work in the enterprises of the field;
- Inclusion of new study courses into the study programme.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

In the review period of the study programme, there was a stable ratio between the number of enrolled and active students. In the review period each year on average 50 students are enrolled on the study programme, and, observing the number of state-financed study places, for 70% of all (local and foreign) interested in the study programme it was possible to provide studies with the state support. Each year in the study programme there were on average 108 students (74% of students study with state support and 26% - paying the tuition fee). On average 20 students per year finish the study programme with a diploma. Such a number in general corresponds to the needs of the labour market and practically all the programme graduates have found work positions in their profession.

Oscillations in the number of students are related to:

- The number of matriculated bachelor students, who are potential master's students.
- Development tendencies of the telecommunication field in Latvia as well as global tendencies.
- Informative and promotional campaigns related to engineering sciences are performed by RTU in general in RTU FET Institute of Telecommunications, in particular, each year.
- The social-economic situation in the country, including employment, and migration.

Table 1: Dynamics of the number of students in a master level study programme "Telecommunication Technologies and Networks Management"

Study year	Academic master level study programme "Telecommunication Technologies and Networks Management"							
	Enrolled in the 1st year		Study in the programme			Exmatriculated		
	State	Fee	State	Fee	Active foreign students	With diploma	Academic failure	Due to other reasons
2013/2014	60	6	101	4	7	42	8	10

2014/2015	41	13	103	11	15	29	9	4
2015/2016	47	23	99	29	32	46	3	2
2016/2017	44	19	96	36	46	36	10	11
2017/2018	20	31	61	55	56	28	17	10
2018/2019	35	23	73	51	51	22	11	18
2019/2020	12	13	68	28	28	32	3	15
2020/2021	15	7	64	18	19	24	9	4
2021/2022*	-	6	53	14	15	9	14	-
Average per year	**35**	**15**	**80**	**28**	**30**	**30**	**9**	**8**

* Data until 15.02.2022.

The total number of students in the master study programme has fallen, in the study year 2013/2014 in the study programme "Telecommunication Technologies and Network Management" there were 101 students in total with state financing, but in the study year 2021/2022 - 53 students.

A decrease in the number of students is observed in the last few years, which is connected with the changes in the modern labour market, and the demographic situation in Latvia. Already in the bachelor level studies, students acquire sufficient knowledge to successfully present themselves in the labour market.

Each academic year drop-outs of students are observed. As the main reasons for the drop-outs, it is necessary to mention student exmatriculation for academic failure and voluntary exmatriculation. Less students are exmatriculated due to not continuing studies after academic leave and due to not continuing studies after matriculation. This can be explained by the fact that the majority of the students, who enrol to master studies, are working, and this produces difficulties in the study process. Not all of them can combine work with their studies and students choose the option to leave their master's studies. Actually, in the master's studies, only students remain, who would like to continue their advancement in science, and enrol on doctoral studies after finishing their master's studies.

Since 2014/2015 the number of foreign students has increased and on average 30 foreign students, who are very positive and show that the programme is important also abroad. As to the analysis of foreign students, it is necessary to mention that all of them are full-time students and are paying the tuition fee.

The number of students using the mobility programmes, in this case, is 8 students per year on average.

Foreign students are mostly from Asian countries, and the wide popularity of the study programme was achieved thanks to the active involvement of the Foreign Student Department and the director of the study programme, participation in international conferences and actively promoting the recognizability of the study programme.

Statistical data on the academic master study programme “Telecommunication Technologies and Networks Management” are summarized in Appendix P05_3.1.4_EMC0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The master level study programme “Telecommunication Technologies and Network Management” is created according to the requirements of the labour market and the newest scientific tendencies. The study programme has been implemented for more than 25 years and has not lost its significance and importance, it is continuously developing, in the world a series of technological solutions have appeared for provision of communications the programme has been accredited several times, the last accreditation was in 2013 (Accreditation page No 2020/38) and the accreditation expiration date is 31st of December, 2023.

The place of implementation of the study programme is Riga. The type of implementation is full-time intramural studies (2 years). In the standard planning of RTU in each study year, there are 2 semesters, the length of each semester is 20 weeks - 16 study weeks and 4 session weeks.

The content of the study programme is updated according to the tendencies of the field, labour market and science development. Each year the study programme is improved and the content thereof is updated, taking into account the results of student surveys as well as recommendations from the employers. The vision of the master’s academic study programme “Telecommunication Technologies and Network Management” is implemented on the basis of the opinion of students, graduates, employers, and professional and non-government organisations, observing the direction stated in the development plans of Latvia and according to RTU mission and vision, objectives and tasks.

The competitiveness of the study programme is confirmed by the fact that all graduates are required in the labour market and are employed in their speciality just after graduation of studies.

The information included in the study courses is subordinate to the objective of the study programme - to acquire deeper knowledge and skills for the improvement of professional competence as well as to acquire skills for application of the obtained knowledge and skills in practical work. In the study programme, a connection is provided between the information included in the study courses, the achieved results, defined objectives, and methods as well as a connection to each study course with the objectives and achievable results of the study programme. The objective of the programme has been developed according to the needs of the national economy and society. The programme objectives are created so that students are educated according to requirements of the 7th Latvian qualification infrastructure level, as well as to promote the competitiveness of students in changeable social-economic conditions and in the international labour market.

The study programme is implemented in the form of lectures and practical classes, reserving significant time for independent studies. The content of the study programme corresponds to the requirements of the normative acts, and is created by observing RTU Senate decision conditions "About common requirements for study programmes".

The duration of the studies is 2 years, which are split into 4 study semesters, during which compulsory study courses, specialisation and free option study courses are acquired. At the end of the studies, a master thesis shall be elaborated.

the volume of the study programme is 80 CP (120 ECTS). The programme can be obtained by applicants with an academic or professional bachelor's degree in engineering sciences or education comparable thereto.

The anticipated volume of compulsory study courses of the study programme is 34 CP (51 ECTS). The compulsory course of the study programme provides knowledge for students in the field of telecommunication technologies and network management, develops knowledge about the topical problems of the telecommunication fields and includes knowledge about scientific research methods and application thereof.

The compulsory elective (specialisation) study courses of the study direction (18 CP or 27 ECTS) are anticipated for potential students to be able to deeper their knowledge in the chosen specialisation field. There are also humanitarian and social study courses included in the study programme (4 CP or 6 ECTS) as well as free option study courses (4 CP or 6 ECTS). The programme acquisition is finished with a master's thesis (20 CP or 30 ECTS).

The programme structure and all formal conditions correspond to state normative acts and to the requirements defined in RTU Senate decisions. If students have not acquired the requirements defined in Environmental Protection Law and Civil Protection Law in lower-level study programmes, students have an opportunity, within the framework of the master study programme, in the part of free options courses to additionally choose study courses "Civil Defence" in the volume of 1 CP (ICA301) and "Environment and Climate Roadmap" 1CP (VAS038), as well as students of the programme branch in English, may choose Latvian language, study course "Latvian language for foreign students" in the volume of 1 CP (VLS711).

Table 2: The study courses included in the study programme

No	Code	Name	Credit points

A		**Compulsory Study Courses**	**34.0**
1	RDE417	Physics of Optical Information Processing	4.0
2	RDE701	Telecommunications Theory (special course)	5.0
3	RDE419	Fibre Optic Transmission Systems	5.0
4	RAE473	Computer Technologies in Telecommunications	3.0
5	RDE425	Research Seminars	4.0
6	RDE432	Transmission Systems (special course)	4.0
7	RDE410	Design and Maintenance of Telecommunications Networks	4.0
8	RDE703	Microwave Telecommunications Systems	5.0
B		**Compulsory Elective Study Courses**	**22.0**
B1		**Field-Specific Study Courses**	**18.0**
1	RAE556	Mobile Communications Systems	3.0
2	RAE419	Telecommunications Marketing	2.0
3	RAE411	Telecommunications Software	4.0
4	RAE472	Digital Switching Systems	3.0
5	RAE553	Signalling Systems and Protocols	3.0
6	RDE431	Telecommunications Pricing Policy	2.0
7	RAE541	Encoding and Encryption	4.0
8	RAE475	Telecomunications and Computer Networks	5.0
9	RAE555	Teletraffic Theory	3.0
10	RDE713	Digital Optical Communication Systems	4.0
11	RDE714	Quantum Communication	6.0
12	RDE715	Metaphotonics in Telecommunications	4.0
13	RDE716	Microwave Photonics Devices and Systems	6.0
14	RDE717	Hybrid Optical Fibre-Wireless Communication and Networking	4.0
15	RDE718	Basics of Integrated Photonics	4.0

16	RAE713	Management of Telecommunications Projects	4.0
17	RAE714	Telecommunications Network Management	6.0
B2		**Humanities and Social Sciences Study Courses**	**4.0**
1	IVZ845	Enterprise Management	4.0
2	HSP484	Psychology	2.0
3	HSP446	Pedagogy	2.0
4	HFL432	Ethics	2.0
5	HFL433	Presentation Skills	2.0
C		**Free Elective Study Courses**	**4.0**
E		**Final Examination**	**20.0**
1	RDE002	Master Thesis	20.0

Lecture courses are generally theoretical, where research elements are embedded for students in the form of theses, research and other independent works. The orientation of practical classes is individual, where within the common topic each student elaborates on an individual study project. Acquisition of knowledge, skills and competencies in special subjects is monitored in the form of individual consultations. Attendance of practical classes is compulsory for all students during the whole period of studies.

During the study period of each study course, students have to pass the planned tests, and elaborate individual homework and study papers. Taking examinations is allowed only for those students, who have fulfilled all the requirements anticipated in the programme of the study subject. Results of examinations and tests are fixed in the RTU study management electronic database.

During the time of elaboration of the master thesis, interim checks for master thesis elaboration progress are organized, where students present their progress of the research to the responsible teaching staff. The check includes:

- regular meetings with a scientific advisor of a master thesis;
- the last second-year students at least one time per month report about their progress in the elaboration of the master thesis.

At the same time, it is necessary to underline that all teaching staff involved in the implementation of the study programme perform research work, which is reflected in publications and participation in the projects.

When implementing the study programme, its objective is to prepare experts, who are able to think systematically, analyse, develop, and introduce new engineering technical solutions we well as manage telecommunication technologies and networks thereof. In addition, to develop the ability of students to perform scientific work, participate in local and international projects and continue studies in the doctoral study programme.", corresponds to the level 7 of the European Qualification Framework (EQF) and Latvian Qualification Framework (LKF).

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The degree awarded by the study program is "Master Degree of Engineering Science in Telecommunication Technologies and Networks Management". The telecommunications industry has been developing rapidly in recent years, and the quality of the Institute of Electrical Communications Infrastructure is at a very high level. The indicators of the industry are increasing and in the future, the synergy with the economy and other sectors of the economy will be even more important for the telecommunications industry. Modern development trends determine the introduction of more and more complex telecommunication technological solutions in daily production and economic processes. It also determines the vision of the study program regarding the potential employment and possible specializations of its graduates. The study program has had more than 30 graduations, and all its graduates have successfully found jobs in the public sector, municipalities and the commercial sector, which shows the competitiveness of the study program. Many graduates work in public administration and hold leading positions in ministries and other institutions.

In the study programme topicality of the content of the study course is provided as well as correspondence to the field of telecommunication technologies, the needs of the labour market and the newest scientific findings.

The study programme has been popular for more than 25 years. The objective of the study programme is to prepare specialists, who are described by an ability to think systematically, analyse, elaborate and introduce engineering and technical solutions in the field of telecommunications, as well as to develop in students the ability to perform scientific work, participate in local and international projects and to continue studies in the doctoral study programme. One of the study programme objectives is the development of scientific research skills. This is achieved by including in the content of the study courses the newest scientific achievements, implementing research within the framework of the study courses, involving students in scientific research projects and performing research during the preparation of graduation papers. Students are provided deeper academic, practical and professional knowledge in the fields of telecommunications, fibre optics transmissions and information technologies. Graduates of the study programme have an opportunity to apply their skills and abilities in both Latvian and international enterprises, which operate in the field of telecommunications or information technologies. Graduates can develop their further careers in the enterprises of the field, which specialise in elaboration, introduction and administration of various products and solutions in the field of telecommunications and ICT at government institutions, which regulate communications etc. Due to rapid changes in technologies, the study programme is not focused on any of the current, actual, certain technology, but on the fundamentals, which unite all these technologies.

Currently, in the higher educational institutions of the Baltic States, this is the only programme, where it is possible to acquire highly qualitative knowledge in the creation, and exploitation of communication systems as well as in the development of future infrastructure development on a national scale. This required serious financial and human capital resources of RTU in the previous years, which resulted in significant achievements in the field of telecommunications, providing scientific achievements to communication specialists.

There were more than 30 graduation ceremonies in the study programme, and all the graduates successfully found work in the public sector, municipal and commercial sectors thus proving the competitiveness of the study programme. A large part of the graduates work in the government and hold leading positions in ministries and other institutions.

An important role is given to practical and theoretical research. Students elaborate on graduation papers about the topical issues in the field by researching and analysing scientific and professional literature in libraries and international databases. The obtained knowledge and findings students use during their studies when analysing issues related to telecommunication technologies and network management. Research results are presented by students at the annual RTU Student scientific conference and are summarized in their master theses, which are defended in public at the end of their studies.

Awarding of the master's degree is based on reviewed theoretical research - defence of the master thesis. The topic thereof is related to the newest scientific findings in the telecommunication field.

It is necessary to underline that the name of the study programme also corresponds to the newest trends in the field of telecommunication technologies, as well as the amendments and additions performed during the period of accreditation are fully reconciled with the corresponding development trends in scientific fields. Thus, it is possible to state that the content of the study programme, the academic staff involved in the implementation thereof, as well as the nature of performed changes fully correspond to the development trends and needs of the corresponding scientific fields and the industry.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study programme is implemented by joining theoretical and practical knowledge and skills in the form of lectures, seminars and practical activities. In the study programme, the study courses and elaboration of the graduation paper are proportionally distributed by semesters so that they append each other by providing students acquisition of the targeted knowledge and skills. In general, the study programme and each semester plan are created by focusing on the acquisition and strengthening of theoretical and professional skills of each student by working individually or in a team.

Assessment of study results takes place according to the Regulation for assessment of learning outcomes and the Regulation for final examinations at Riga Technical University.

The teaching staff responsible for the study courses, according to course content and programme specification, as well as student needs, choose the structuring, teaching and evaluation methods of the study courses. There are courses and seminars organized for the academic staff about the newest pedagogical methods, as well as attendance to qualification raising and upgrading courses is promoted within the Faculty, RTU and worldwide. RTU academic excellence centre organizes academic staff training events at the university level.

The study program is implemented in Latvian and English and provides for full-time studies. When implementing the content of the program, the requirements formulated in regulatory acts and the basic principles of study process organization determined by RTU are taken into account, as well as all study course requirements are met. The course descriptions of the study program define a set of relevant knowledge, skills and competencies and their evaluation system, and define the expected study results, for the achievement of which credit points are awarded. The full-time type of study corresponds to 40 CP in the academic year. In master's studies, 40% of the workload is contact hours and 60% is independent work.

In providing the content of the study program (Latvian and English languages), the pedagogical methods are chosen by the teaching staff responsible for the study course, according to the specifics of the study program and the needs of the students. The study process is organized in the form of lectures, laboratory work and practical work so that students acquire both theoretical and practical knowledge. Various study methods are used in it: lectures, seminars, presentations, group works, discussions, situation analysis, solving practical tasks to strengthen knowledge and control tests - to test knowledge. In order to inform students about the latest trends in the industry, guest lectures by industry experts and company representatives are held regularly.

The methods used in the study programme promote the acquisition of objectives and results of the study courses and the programme. In improving the study process students can express their wishes to the teaching staff of the certain study course, the head of the group, the programme director or with the help of student self-government, representatives of which are members of the Council of the Faculty of Electronics and Telecommunications (FET), RTU Senate and RTU Senate commission as well as members of RTU Academic council. FET make relationships with students on the basis of principles of mutual trust, respect and integrity. Students are provided with an opportunity to influence their own process of studies, implement their own autonomy, to submit feedback on the process of studies by combining it with their own professional growth interests. A large role in the provision of linkage among students, teaching staff and programme administration is given to the FET student self-government, which actively takes part in all the mentioned processes and performs an annual assessment of the teaching staff.

When starting the study course, the teaching staff inform students about the requirements for the acquisition of the study course and introduces to students the assessment criteria of the study course. All information is published in the electronic environment of study courses ORTUS. Once per semester students assess the work of the teaching staff in the ORTUS environment by answering a questionnaire. This includes assessment of the advancement of studies, individual tasks, acquired skills, relationships and cooperation of a teacher with students. Questionnaires are anonymous.

In the study programme, complete implementation of study results is provided. The study results are formulated both at the study programme level and at the study course level. The achievable learning outcomes are discussed with students at the beginning of each study course, and also such information is available in the ORTUS environment. A linkage is provided between the achievable results of the study programme and those of the study courses. According to the achievable results of the study programme, content and volume in credit points of study courses are created, and in its turn, according to the achievable results of the study course, topics and volume thereof are created. In all study courses, the achievable results are verified with the corresponding assessment methods.

During the implementation process, the study programme is appended and updated on the basis of science development, labour market research and consultations with employers and practising experts. Recommendations received from graduates, students and teaching staff of the university are significant for the improvement of the study process.

Many various study methods are used in the pedagogical process: individual and group work, individual and group consultations, presentation of results, project work, tests, verbal and written examinations, practical laboratory works, discussions etc.

A significant role is given to the independent learning of students. Description of independent work is included in the description of the study course as a compulsory component. The ability of students to learn independently is purposefully developed in all study courses. Students acquire practical and research work skills by regular use of literature and Internet resources, including international scientific databases, which are available at RTU library with electronic access to the ORTUS environment, in order to successfully elaborate research study papers.

The centre of RTU structural units, including staff, science, international relations, studies and also Academic excellence regularly inform the staff about opportunities to improve their competencies in scientific research and methodological and digital skills in the field of general competencies and specific professional activity. In the ORTUS environment information about the scientific activity of the academic staff is stored. To perform pedagogical work at a high level, methodological seminars are organised for RTU teaching staff about opportunities for the application of various learning methods, experiences and best practices.

Academic staff of the programme regularly improve the content of studies by introducing to the study process new, innovative study organisation and learning methods, the main objective is to teach how to learn, look for information, use various sources of information, discuss, work together with others, make decisions and take responsibility. Cooperation here is done in both directions, student-student and teacher-student. International experience is integrated into the study process.

During the studies, the student-centered approach is adopted. In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific undergraduate paper research, and the choice of a particular major, as well as in group work, which to a large extent also allows the manifestation of organizational skills, leadership qualities and other transdisciplinary skills.

In order to enable effective use of the study materials for practical and independent work, RTU uses the ORTUS e-learning environment, and additional communication opportunities provided by this system as well.

Analyzing the study implementation and results in evaluation methods used in the study program, it must be concluded that the principles of student-centered education are consistently observed:

- the student contingent and the diversity of their needs are taken into account and respected when creating suitable learning paths;
- different ways of implementing the study program have been used;
- guided by the student’s abilities and needs, the teaching staff uses diverse pedagogical methods and encourages the student's desire for independence, while at the same time providing the teacher's guidance and support;
- the conduct of the study process in the study program promotes mutual respect in the relationship between students and teaching staff, as the principle of democracy is observed and the administration of the study program takes into account the opinion of students.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Not applicable.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

At the end of the programme, students have to elaborate a master thesis (20 CP or 30 ECTS), which is devoted to actual problems in the fields of telecommunication technologies and network management. The master paper is defended in public before the Final examination commission. The commission acts according to the regulations approved by the Senate of the university "About approval of a new edition of the regulation on study final examinations in Riga Technical University ".

The topics of students' graduation papers are chosen according to the most relevant topics in the field in Latvia and in the world. In the case of master theses, each student has a possibility to choose a research field and topic of the graduation paper independently according to his own interests, consulting with the teaching staff, as well as choose one of the topics offered by RTU FET Institute of Telecommunication, which are also based on research topics of Institute of Telecommunications scientific projects. The objective of the master thesis is to provide students with an opportunity to perform solutions to research tasks on the basis of the acquired knowledge during studies, to make decisions in a reasonable way, to logically sequentially and reasonably express and present the acquired results by proving the abilities to perform scientific work and discussion at high professional level in the field of telecommunications. Students acquire abilities to perform research work by regularly working with literature and internet resources, which allow the successful elaboration of a master thesis. Students can present their research works at student conferences. The final examination commission of RTU FET Institute of Telecommunications evaluates the participation of students in scientific and research activities (conferences, publications), assigning higher marks for this. For example, in 2017 at the student conference, 6 students took part, in 2018 – 2 students, in 2019 – 5 students, in 2020 – 5 students, and in 2021 – 6 students.

Below are examples of graduation paper topics given for the master's study programme "Telecommunication Technologies and Network Management".

The study year 2013/2014

- Analysis and Evaluation of Optical Bistability in Microring Resonator
- Bridging over Provider Backbone Network
- Development and Analysis of Fuzzy-Logic Based TCAS System for Small Aviation
- All Optical Modulation Format Conversion in Fiber Bragg Gratings
- Use of Polarisation-Division Multiplexing for Spectral Efficiency Improvement in WDM Systems
- Application of neural networks for simulation of analog devices
- Evaluation of Electromagnetic Compatibility of LTE and DVB-T Systems in 450-470 MHz band
- Electromagnetic Compatibility Assessment of LTE and Wi-Fi in the 2.3-2.4 GHz Range
- Analysis of SIP Application over IMS
- Analysis of Dispersion and Attenuation Parameters on Optical Soliton Transmission Systems
- Investigation of Hybrid WDM/TDM PON System with Data Rate up to 10 Gbit/s per Channel
- All-Optical Clock Signal Recovery with Microring Resonators

The study year 2014/2015

- Evaluation of Chromatic Dispersion Compensation Methods in WDM-PON Systems
- Simultaneous Intensity and Phase Modulation Format Conversion in Fiber Bragg Grating
- Development of Mobile Network Parameter Testing Application with Android
- Realization and Analysis of Security in SIP-based VoIP Networks
- Evaluation of Optical Fiber Manufacturing Process and Parameters Analysis
- Openflow Protocol Performance Evaluation in Software Defined Networks
- Active network measurements in 4G networks
- Electromagnetic Compatibility Evaluation of LTE FDD Networks in 800 MHz Band
- Influence of Microwave Link Parameters on Interference Level on Receiver
- LTE Technology Opportunities for Image Transmission
- Analysis of Next-Generation Core Network Services
- Research of Channel Placement in WDM Systems with Data Rate up to 100 Gbps
- Relationship Between Spectral Efficiency and Energy Efficiency in WDM Transmission Systems
- 900 MHz Frequency Range Optimization for UMTS/LTE Technology Usage
- Analysis of Traffic Processing with Cisco Adaptive Security Appliance
- Evaluation of DB and DSPK Modulation Formats in WDM Transmission Systems
- Research of 4-PAM Generation and Application in Optical Access Systems

The study year 2015/2016

- Analysis of Database Vulnerabilities and Security Measures
- Research and Application of Dispersion Compensation Methods in WDM-PON Transmission Systems
- PIM Protocol Analysis and Traffic Rupture Reduction Methods
- Assessment of the Openflow Protocol Application
- Hata Radiowave Propagation Prediction Model Calibration in the 1800 MHz Frequency Range
- Research of RAMAN Amplification in Fiber-optic Communication Systems
- Determination of Optical Fiber`s Effective Area Using Transverse Offset Method
- Effectiveness Evaluation of Dispersion Compensation Methods in FOTS

- Performance Evaluation of IEEE 802.15.4 Standard
- Analysis and Architecture of M2M Wireless Mesh
- Quality Evaluation of Internet Access Services in LTE Network
- Evaluation of the HNLF Optical Fiber for Optical Signal Regeneration
- Nonlinear Optical Effects in Wavelength-division Multiplexing Systems
- Evaluation of Electromagnetic Compatibility of LTE 450 and CDMA Systems
- LTE Radio Parameters Impact on Service Availability

The study year 2016/2017

- The Usage of OTDR for GPON Solutions
- Passive Optical Installation and Measurements With OTDR
- An Analysis of Ytterbium-doped Fiber Effective Area
- Evaluation and Modernization Analysis of Intelligent Street Lighting System
- Research and Application of Four-Wave Mixing Effect in WDM Access Systems
- Evaluation and Analysis of DSL Technology Performance
- The Role of Software-defined Networks in Cloud Computing
- Analysis and Assessment of 4G Wideband Wireless Network
- Electromagnetic Compatibility Evaluation of LTE Networks in 900 MHz Band
- Electromagnetic Compatibility Assessment of LTE and Wi-Fi in the 2,4 GHz Range
- Assessment of Reliability Parameters in the Fiber Optic Transmission Lines
- Research and Comparison of NRZ and PAM-4 Modulation Formats
- Research of Dispersion Compensation Methods in Fiber Optics Transmission Systems
- Optical Time Domain Reflectometer Application for Assessment of FOTS Line Quality
- Internet Access Service Quality Assessment from Net Neutrality Standpoint

The study year 2017/2018

- Performance Evaluation of ADSL and VDSL Technologies
- SDN Based MPLS Traffic Engineering Assessment
- Analysis of Power Management Techniques for LoRaWAN Networks
- Development and Evaluation of Multi-Functional Fiber Optical Sensor Systems
- LTD TDD and Wi-Fi Electromagnetic Compatibility Evaluation in 2,3-2,4 GHz Range
- Four-Wave Mixing Effect Usage in Realization of WDM-PON Systems
- Assessment of Point to Point Microwave Link Parameters in 38 GHz Band
- EDFA Amplifier Operating Analysis and Application of WDM Communication Systems
- Local Area Network Management with OpenFlow Protocol
- LTE1500 SDL Radio Coverage Parameters Evaluation
- Analysis of Internet of Things (IoT) Experimental Solutions
- Assessment of Fiber Optical Sensor Technologies

The study year 2018/2019

- Research and Comparison of PMD Measurement Methods
- 5G Base Station Radio Coverage Parameter Evaluation in 900 MHz Band
- The Application of Deep Learning Algorithms on Traffic Analysis
- Evaluation of Electromagnetic Compatibility of 5G NR networks in 3,6 GHz Band
- Customer Churn Prediction in Telecommunications Industry
- Development and Evaluation of Fiber Optical Sensor Systems in FOTS Solutions
- Evaluation and Development of Next-generation Spectral-efficient Optical Access Networks
- Analyze of Network Security Problems on Data Link Layer
- Application of FBG Optical Sensors in Fiber Optical Transmission Systems
- Configuration Parameters Assessment of the Microwave Link

- Application of Optical Kerr Effect in Phase Modulated Signal Regeneration

The study year 2019/2020

- Research and Usability of Dispersion Compensation Methods in High-speed WDM-PON Systems
- Evaluation and Development of High Availability DWDM System for Connection Between Data Centers
- Investigation of Hybrid EDFA-Raman Amplifiers
- Cloud Services Solutions in IoT
- Integration of Sensor Systems for IoT Solutions for Smart Cities
- Analysis and Evaluation of Hybrid Wireless Networks
- BER Analysis and Evaluation Depending on FEC in WDM Communication Systems
- Analysis of Network Service Header protocol for Service Function Chaining in Software Defined Network
- Evaluation of Kerr Combs in Nonlinear Microresonator for Optical Fiber Communication Systems

The study year 2020/2021

- Evaluation of a long-distance IEEE802.11ah wireless technology in Linux using Docker containers
- Evaluation of Fiber Bragg Grating Characteristic Parameters for Optical Sensors Solutions
- Investigation and comparison of EDFA and Raman hybrid amplifiers characteristics for WDM transmission systems
- Radio over Fiber technology usage in Fiber Optical Transmission systems for 5G communication implementation
- Application and analysis of EDFA amplifier for WDM transmission systems
- Evaluation of FBG Optical Sensors for Strain Monitoring in Composite Materials
- Research and Evaluation of the Distributed Denial of Service (DDoS) Attacks
- Energy efficiency analysis depending on the encryption method on IoT devices
- Evaluation of the ZigBee protocol performance in the 2.4 GHz frequency band for different network topologies
- Evaluation of WDM-PON Transmission System Interoperability with an Integrated FBG Sensors Network
- Development of a sports hall fire safety systems using telecommunication system design methods

In the Master programme “Telecommunication Technologies and Network Management” the results of students’ final examinations are discussed one time per year at RTU FET Institute of Telecommunications meetings. The results are summarized and evaluated also by the programme administrators and are used as a basis for further improvement of the study process.

In the review period from 2013/2014 until 2020/2021 study years, the average evaluation of the graduation master theses on the 10 point scale was 8,62.

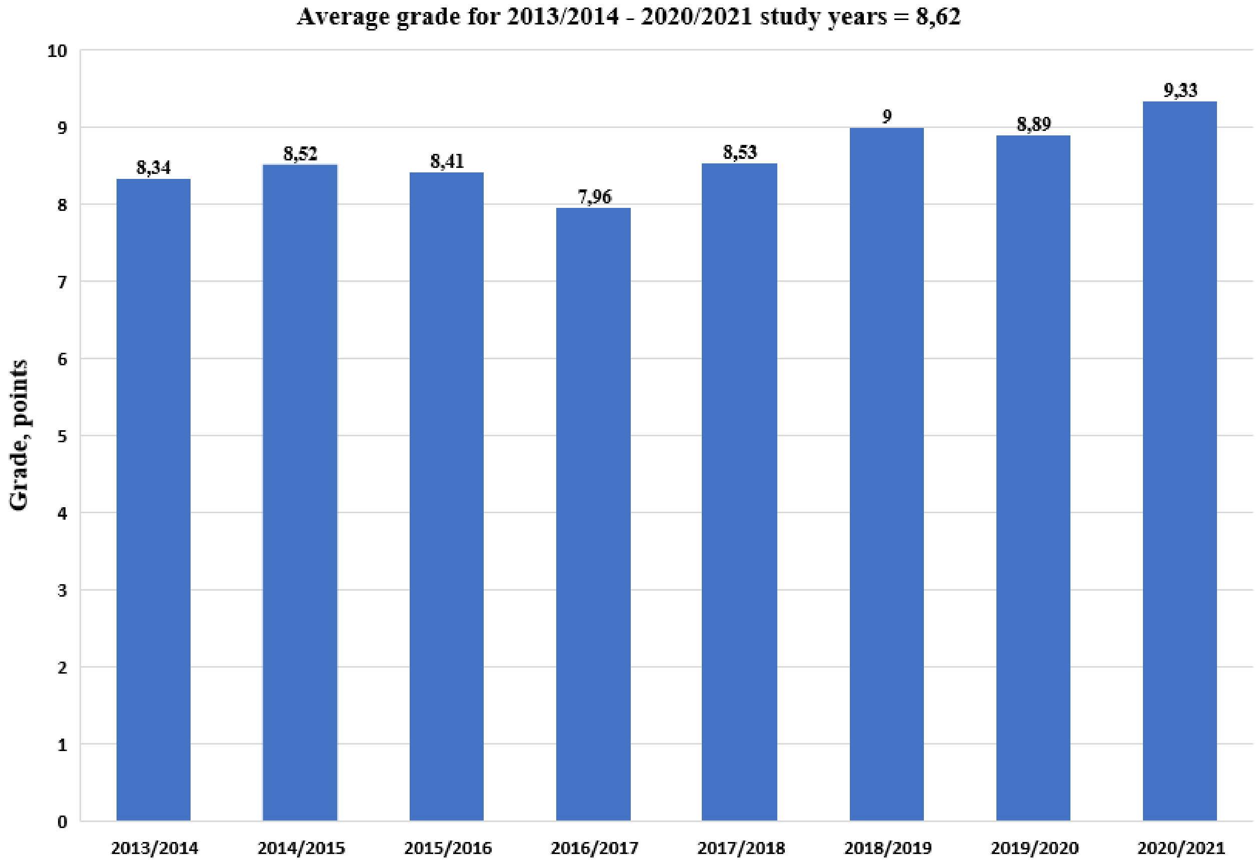


Figure 1: Average evaluations of graduation papers within the review period in the master study programme "Telecommunication Technologies and Network Management"

Acquisition of knowledge, skills and competencies is provided during the elaboration of the master thesis. Implementation of the master study programme within the study courses is done in close cooperation with the scientific advisor of the master thesis and the teaching staff of the course - in practical and independent work at the study course level, deepening student's knowledge in a certain research field with the help of the research topic of the master thesis.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU have a decentralized budget, therefore each structural unit has a separate budget. The budget generally means a plan of incomes and expenses for a certain time period, work, event or a function. RTU incomes and expenses are administrated by the principles approved by the Senate or by the vice-rector for finances with assigned powers. Income can be of such categories, which are allocated to a structural unit for work, for which it is responsible, for example, provision of consultations, organisation of training, and which are allocated to a structural unit as the result of calculations, on the basis of the volume of the planned works and/or indicators obtained in the previous periods (i.e., science support). In RTU for each structural unit, the director has remote access to operational financial information about the structural unit budget is provided, including the information about the planned volume of works and the corresponding financing in the next periods for implementation of the study programme and the study courses. At the beginning of each finance or budget year, the structural unit director plans the work of the structural unit, including salaries of the academic staff subordinated to the certain structural unit director and elaborates the procurement plan for the next year according to the provision of the study programme or the study course activities and development etc.

For the implementation of the study programme and achievement of the learning outcomes each year material and technical provision is assessed as well as the study and science provision base including printed and digital editions.

According to the volume of the programme financing, regular renewal and improvement of resources and software are performed.

In the implementation of the programme such material resource base is used:

- rooms (for both lectures and practical classes);
- modelling computer laboratories;
- experimental laboratories;
- methodological cabinet;
- RTU Scientific library book and periodic material storage.

There are other RTU infrastructure elements available for the needs of students and instructors - canteens and cafés, copying rooms, student hostels, RTU sport and recreation centres, swimming pool etc. In RTU rooms there are trading automates installed for buying various drinks and snacks, and drinking water is available free of charge. Information storages are regularly renewed and appended with regular and periodic leading world professional and scientific editions and books in the field.

The University library is of major importance for the implementation of methodological and informative provisions for the student. RTU Scientific library is the official state-level library, which obtained its status as a result of accreditation. The library provides all the necessary information for the RTU study process and research activities and performs library, bibliographic and information services for RTU students, academic staff, and employees. In the library collection, there are 1.4 million printed documents and e-resources in the databases corresponding to the RTU fields. Students have access to the databases, for which the RTU library is subscribed:

- **EBSCOHOST eBook Academic Collection** - eBook Academic Collection database contains ~202200 books in various science fields: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.
- **IEEE Xplore Digital Library (IEEE/IET Electronic Library)** - IEEE Xplore Digital Library is the most extensive database packet, where all IEEE/IET full-text journals, conference materials, and collections of scientific papers are available.
- **E-journal and e-book search** - with the help of SFX software it is possible to precisely define the location of an e-resource (e-journal, e-book) in the RTU Scientific Library subscribed and free access databases.
- **SpringerLink** database e-books, available are 18500 e-books (issued within 2014 -2020) in the fields: of computer sciences; engineering sciences.
- **Web of Science** is the leading research platform of electronic resources. The unified

platform provides an integrated approach for high-quality literature, it unites the search for information in bibliographic (also citation index) databases, helps find the newest and the most important scientific publications in the journals with high influence factor, collections of conference proceedings etc., as well as show citation of scientific publications.

- **Latvian standard database** content: Latvian national standards (LVS); European standards adapted to Latvian standard status (EN); International standards adapted to Latvian standard status (ISO); annexes to standards: amendments and corrections. Thematic arrangement corresponds to the internationally accepted International classification for Standards (ICS). Standards can be searched by number, can be read.
- **EBSCOHOST -** EBSCO databases comprise periodical publications in computer sciences, engineering sciences, humanitarian and social sciences, economics, business, medicine and other fields.
- **ProQuest Ebook Central** (earlier Ebrary) database provides an opportunity to read scientific books in electronic format. In the ProQuest Ebook Central platform, a collection of electronic books «Academic Complete» is available, where about 200000 e-books in English in PDF format are found, which were published by the world-leading scientific editions – Elsevier, Wiley, Springer, Oxford Press, Emerald etc.
- **ScienceDirect** is one of the largest databases of scientific, technical and medical articles in the world, which comprises full texts of Elsevier Science edition journals.
- **SCOPUS** (publisher Elsevier) – a bibliographic citation database of scientific literature, created by scientists for fast acquisition of information.
- **ACM Digital Library** offers high-quality publications in computer science – computer security, computer graphics, acquisition of information, mobile technologies, software development etc.
- **WILEY Online Library** database offers a packet of full text scientific reviewed journals „Full Collection".
- **Letonika** is a Latvian information and translation system in the Internet, the main objective thereof is to provide systematized encyclopaedic data and information on translation, by creating new, knowing the existing and maintaining digital resources about Latvia.
- **Learning material repository – MERLOT** The largest free access storage of learning materials in the world, which contains more than 28000 materials and an opportunity to attach own learning materials. Here are also links to more than 500 other learning material repositories, creating unlimited opportunities for online browsing of learning material.

RTU Institute of Telecommunications provides academic and methodological work: creates and renews study course descriptions, provides instruction of the corresponding courses (including practical, laboratory and seminars classes), conduction of graduation papers and the defence thereof and performs other activities related to academic, methodological and scientific work.

The master academic study programme "Telecommunication Technologies and Network Management" has been implemented at the building of FET - Āzenes street 12, Riga. The environment therein corresponds to the modern requirements. All the classrooms anticipated for the study process are equipped with multimedia devices – a computer with access to the Internet, a speaker system, and a projector. Thus, it is possible to provide the modern study process. Students of the study programme "Telecommunication Technologies and Network Management" perform scientific research within the framework of their master thesis and also laboratory work in one of the RTU Institute of Telecommunications laboratories or computer classes mentioned below:

- **Photonics Laboratory**

In this laboratory, students acquire master's study level subjects: "Fibre Optic Transmission Systems" (RDE419), "Digital Optical Communication Systems" (RDE713), and "Physics of Optical

Information Processing” (RDE417). These are the study subjects, which give students basic knowledge in the field of innovative Photonics. In the laboratory replacement of the existing training devices (a part of them has been used since the beginning of the 90s) and components have been done with the devices and components, which are more modern, more related to the field and students and more attractive. The laboratory provides an opportunity for students to obtain an understanding of optical methods of information processing and administration, about development tendencies and prospective thereof, as well as an opportunity to deeper study those sections of Photonics, which form the base of optical processing and transmission of information. Renewal of the laboratory equipment gives an opportunity to involve students and young scientists in research work by implementing various solutions of signal optical processing devices, including applications, which are compatible with radio over fibre systems, 5G, IoT, sensor technologies and not only.

- **Transmission System Laboratory**

Study of AM and FM modulation: during the workshop students get acquainted with amplitude modulation and frequency modulation. In contrast to the bachelor course, here students perform observations and measurements within the range of radio frequencies. Study of ADSL/VDSL transmission system: in their work students get to know ADSL and VDSL transmission system principles, device construction and operation. Perform measurements and performance analysis. Modelling and research of a transmission system: extraction of clock frequency from the active signal. During the work, students create PS in the baseband from the functional unit set, record signals and spectra thereof, and make measurements. The model is activated by changing SNR and observing when transmission error appears. Observation of QPSK constellation, automatic frequency adjustment (PLL), DSSS modulation: in the work students are introduced to square amplitude modulation (manipulation) and observe so called constellation diagram. Create and research PLL, as well as get acquainted with DSSS operation principles.

- **Class of Communication Systems and Telecommunication Networks Mathematical Modelling**

The computer classroom is equipped with 16 computers with various simulation, computation, programming and designing software (Seamcat, HTZ Communication, VPI Photonics, OptSim for Optical Communication, Matlab, Autocad, Java, Python etc). In this computer classroom students acquire master study level courses: RDE417 “Physics of Optical Information Processing”, RAE473 “Computer Technologies in Telecommunications”, RDE703 “Microwave Telecommunications Systems”, RAE556 “Mobile Communications Systems”, RAE411 “Telecommunications Software”, RAE475 “Telecommunications and Computer Networks”.

- **Laboratory of the Internet of Things (IoT)**

This Laboratory of the Internet of Things (IoT) has been established in cooperation with the enterprise Siemens Latvia and is mostly designed for various industrial IoT solutions and the creation of sensor networks. In the laboratory, there are various devices, for example, programmable logic controllers (LOGO, SIMATIC S7 1200), micro controllers (Arduino, ESP), Bluetooth, ZigBee, LoRa, NrF 24, 4G radio receivers, IP network gateways (Simatic IOT 2040, Raspberry PI) as well as various training sets. Here students can elaborate on master paper research, which is connected with the collection of various electronic sensor data and sending them within the IP network for data aggregation and processing students and scientists have access to the IoT cloud platform Siemens MindSphere.

In the period 2013-2022 for the needs of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, in order to provide the study process RTU Institute of Telecommunications procured the infrastructure for laboratories, practical works (i.e., modelling software) and lectures (i.e., scientific literature, scientific article databases), computer hardware (monitors, computers, presentation lasers), laboratory equipment (analyser ELQ-2, oscilloscope GDS-1052-U, virtual instrument PicoScope, GRF-1300 stand for AM and FM research in RF band, spectrum analyser for RF band GSP-730, DSL tester KE3400B (ADSL, VDSL), ADSL/VDSL modem ZXDSL-93, artificial line DLA-200, copper cable 1x4, 5 sections by 100 m, experimental device EMONA tims (this is a universal device with various changeable units, it is meant for research of various signal processing stages), experimental device EMONA 101 biskit (this is a universal device with various switched units, it is meant for research of various signal processing stages), PC oscilloscope PicoScope 3206D (virtual oscilloscope and spectrum analyser), USB SDR (Software Defined Radio) receiver.

For all study courses, methodological materials are regularly updated and uploaded by the teaching staff in the ORTUS environment.

The study process is provided mostly by the staff of RTU FET Institute of Telecommunications (13100). In addition to the professional specialisation part (B1 part) and humanitarian and social study course part (B2 part) such structural units are involved:

- Innovation and Entrepreneurship Management Academic Department
- Enterprise Finance and Economics Academic Department
- Social Science Academic Department
- Engineering Pedagogy and Psychology Academic Department

For the provision of quality, a digital student survey system is used, which helps in controlling the quality of study courses and study programme implementation each semester. On the basis of the quality control results, regular measures for improvement of the study programme and processes are performed.

The total assessment of the resources is reflected in the data provided in part II Section 3, criteria 3.1.-3.3. of the Study Field Report.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The financing source of the master’s study programme “Telecommunication Technologies and network Management” are the funds of the state budget and tuition fees of natural persons.

In the 2021/2022 study year, the programme has 60 state budget financed seats. The tuition fee for the academic master’s study programme “Telecommunication Technologies and Network Management” is 4000 EUR.

Table 3: Information on the financial resources of the programme

Study year	Grant for the programme, EUR	Tuition fee for the programme, EUR		Total financing for the programme, EUR	Financing of one state budget seat, EUR
		Tuition fee for local students, EUR	Tuition fee for international students, EUR		
2013/2014	308181.00	-	-	308181.00	5799.00
2014/2015	314772.89	-	-	314772.89	5799.03
2015/2016	285846.82	-	26435.38	312282.20	5799.03
2016/2017	272815.93	-	94489.53	367305.46	5799.03
2017/2018	273893.06	-	115384.68	389277.74	6060.99
2018/2019	328969.03	-	108050.76	437019.79	6344.52
2019/2020	232490.50	-	137676.95	370167.45	6607.56
2020/2021	288166.09	-	82957.20	371123.29	6694.22

The financing of one study seat has increased - in the academic year 2020/2021 by 14% in comparison to the academic year 2013/2014.

The information about the distribution of the funding among cost items is given in the self-assessment report of the study field in the annex “Distribution of funding among the cost items”

Information about the minimal number of students in the programme is given in the self-assessment report of the study field in the annex “About_the_minimal_number_of_students_in_study_programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on

how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The teaching staff of various levels and professional qualifications are involved in the implementation of the study programme to make the implementation of the study courses of the programme as qualitative as possible. In total in the implementation of the master's academic study programme 7 professors, 3 associated professors, 9 docents and 7 lecturers, 2 senior researchers (guest associate professors), and 1 scientific assistant are involved.

During the review period, more than 15 new members of the teaching staff joined the implementation of the study programme by supplementing the research field list and opportunities for students to choose a supervisor for a graduation paper, who is a professional in the corresponding research field. Qualification of the teaching staff of the programme study courses corresponds to the programme implementation requirements. Highly qualified scientists and field specialists take part in the programme implementation.

The basis of the selection and renewal of a qualification improvement policy of the academic staff is the regular involvement of master’s students and master’s study graduates and doctoral students in the study process.

Qualification of the teaching staff involved in the implementation of the study programme fully corresponds to the study programme implementation conditions and requirements of the normative acts, provides achievement of the corresponding study programme and study course objectives, tasks and study results (see CVs of the teaching staff). RTU elected teaching staff, guest lecturers and leading experts in the field are involved in the implementation of the master’s study programme “Telecommunication Technologies and Network Management”. RTU elected staff is responsible for the content of the study course and the creation thereof. In the master’s study programme the responsible teaching staff have the corresponding education. RTU elected academic staff and guest teaching staff of the field also take part in the implementation of the programme.

According to the study programme tasks, the primary criteria for selection of the teaching staff are:

1. knowledge about the newest technologies and participation in scientific and research projects in their fields;
2. pedagogical skills corresponding to the modern trends in the field;
3. experience in teaching study courses to foreign students in English.

To provide quality with the study courses, the teaching staff involved in the implementation of the programme regularly improve their professional and academic knowledge at methodological seminars, and conferences (on a national and international scale), as well as in research and scientific work (see CVs of the teaching staff), take part in various scientific and methodological projects.

There are 6 professors from RTU FET Institute of Telecommunications, who take part in the implementation of the study programme - doctors of science, who are elected as professors and whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for a professor’s position.

To summary reports about the qualification of RTU FET Institute of Telecommunications professors (as was mentioned before, 71% of all the teaching staff are professors of RTU FET Institute of

Telecommunications, from other structures - 39%) are given below:

Vjačeslavs Bobrovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: dean of FET. Professional experience: academic and scientific work experience of more than 15 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics, wavelength division multiplexing, passive and active optical networks, microwave telecommunication systems, mobile networks, wireless communication systems), natural sciences - Physics and Astronomy (optical processing physics, conference, optical waveguides, lasers, optical elements, fibre optical elements), engineering sciences and technologies – nanotechnology (nanoparticles, nanophotonics, nano aerials, metaphotonics, anapole state, anapole dynamics, integrated photonics). Director of the academic bachelor's study programme “Telecommunication Technologies and Data Transmission Engineering”, the academic master's study programme “Telecommunication Technologies and Networks Management”, and the academic doctoral study programme “Telecommunications”. Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, RTU Scientific Council, member of the Senate and Constitution Board, member of the RTU Electronics, Information and Communication Technologies, Computer Sciences and Information Science. Member of IEEE since 2012. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 13, co-author for 17 patents. Researcher or project manager in more than 15 projects in total. More than 80 bachelor papers, 85 master papers, and 7 promotion works are advised and successfully defended. Participated in ERASMUS academic staff exchange. Regularly participates in professional training and academic seminars.

Andris Ozols, Dr.habil.Phys., professor, senior researcher, RTU, Faculty of Materials Science and Applied Chemistry (MLĶF), Technical Physics Institute, Optics Group; Head of Group. Chair of RTU Natural Sciences, Physics and Astronomy Professor Council. The direction of scientific research is material optics, dynamic holography, physics of optical recording and transmission of information. More than 50 years of experience in the field of higher education: administration of the study courses, scientific research, and project management. Since 1998 A. Ozols has been a corresponding member of the Latvian Academy of Science, but since 2010 he has been an academician of LZA. From 2010 until 2016, A. Ozols was elected as a member of the commission of experts of Natural Sciences and Mathematics of the Latvian Council of Science. Currently, he is a vice-chair of the LZA Physics and Technical Sciences Department. Concurrently to the above mentioned, A. Ozols is also a vice-chair of the Joint Council of Astronomy and Physics Professors of RTU and Daugavpils University. LZP expert in the fields of engineering sciences and technologies - Material Science (Solid State Physics, Holography, Laser Spectrography, Photo Induced Processes in Matter, Nano structures, Information Technologies). In 2017 professor Andris Ozols received a Certificate of Appreciation from the Cabinet of Ministers for significant contribution to the development of optical technologies and active participation in the work of Latvian Academy of Sciences. The total number of works: scientific – 253, including 131 scientific articles, from which 75 are published in cited scientific journals; 11 methodological works; 37 popular science articles. The professor is the advisor for bachelor, master and doctoral level students in the subjects related to nanophotonics, theory of electrical communications, physics, signal transmission theory, optical record physics, nano structured nano materials.

Ģirts Ivanovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. More than 40 years of experience in the field of higher education: administration of the study process, scientific research, and project management. LZP expert in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies (electrical communications, microwaves, optics, fibre optics, WDM, filters, optical filers, PON, optical amplifiers). For more than 10 years, he has been the director of the Institute of Telecommunications and the director of the academic bachelor's, master and doctoral study programme "Telecommunications". Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, member of Institute of Telecommunications Council, and Member of the Board of the Latvian Telecommunication Association for more than 10 years. Co-author for 85 scientific publications available in the Scopus database, and his H-index is 11, co-author for 11 patents. The professor implements study courses: "Communication Transmission Lines", "Fiber Optic Transmission Systems", "Electrodynamics of Driving Systems", and "Optical Transmission Lines", as well as participates in the elaboration of the bachelor papers as a scientific advisor. More than 35 bachelor papers, 40 master papers, and 4 promotion works are advised and successfully defended. Researcher or project manager in more than 10 projects in total.

Jurģis Poriņš, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: Head of Group. Professional experience: academic and scientific work experience of more than 27 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics; non-linear fibre optics; non-linear optical effects in fibre optics transmission systems; optical wavelength division multiplexing systems and elements; optical amplifiers; safety parameters in communication lines; sensors and sensor networks), natural sciences - Physics and Astronomy (non-linear fibre optics, study and application of non-linear fibre optics effects, polarization effects and assessment thereof, laser equipment, optical amplifiers, optical frequency combs and application thereof). Expert of the Latvian Council of Science (LZP) since 2012 and corresponding member of the Latvian Council of Science (LZP) since 2018. Director of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, Director of FET Council. From 2015 until 28.02.2022 was the dean of FET and administered the Faculty. Member of RTU Council since 01.03.2022. In total, there are 87 publications published in internationally cited editions and reviewed scientific editions and conference proceedings (from the 52 in Scopus database, H-index is 8), as well as 8 scientific monographs, which are available in EBSCO, ISI WEB of Science, INSPEC, VINITI, VERITAS, Intech and other databases. There are 7 articles published in popular science journals. Participated with theses in 82 international and Latvian scientific and technical conferences. Also participated in panel discussions 5G Techritory forum 2020, UL Student scientific conferences in the discussion about the influence of COVID-19 on science and in other events, as well as took the floor radio broadcasts LR1 "Known in the unknown" (in Latvian: "Zināmais nezināmajā"), and also on television broadcasts TV3 and LTV7. 56 bachelor papers, 62 master papers and 2 promotion works are advised and defended. Implements 8 study courses and qualification upgrading courses for representatives of the field of telecommunications. Co-author for 12 patents. Researcher or project manager in 7 projects in total.

Sandis Spolītis, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Communication Technologies Research Centre: head of the centre. Scientific research directions: research and development of innovative fibre optics communication systems, signal processing and coding, optical frequency comb sources, radio over fibre systems, optical processing physics, optical elements and components. Published >80 scientific articles (indexed SCOPUS), 2 monographs. Co-authors of 5 Latvian patents, H-index 10. Participation in >10 international conferences with theses (verbal and stand messages). Advised and successfully defended 18 bachelor and 17 master papers, 5 promotion works (2 are defended), administration of the study courses of RTU Faculty of Electronics and Telecommunication, Institute of Telecommunications "Telecommunication systems", "Scientific workshops in the field of telecommunications" and "Scientific workshops". The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application-oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Traineeships in the Photonics Institute of the Technical University of Denmark and the Photonics Technologies Integration Centre of the Photonics Integration Institute of Eindhoven Technical University. Member of the RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies", member of the RTU Constitution Board, member of the Council of RTU Faculty of Electronics and Telecommunications, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies" and "natural sciences - Physics and Astronomy". Participation in international scientific associations – IEEE and SPIE. Reviewer of scientific articles of strong influence (Applied Sciences, IEEE Access, Micromachines, Chinese Optics Letters, Fiber and Integrated Optics, Optik, Optics Letters) and a member of international scientific conferences- FOAN, RTUWO, MTTW technical programme committee (TCP).

There are 6 associated professors and 2 professors from RTU FET Institute of Telecommunications, who take part in the implementation of the study programme - doctors of science, who are elected as associated professors and whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for an associated professor's position.

To summary reports about the qualification of RTU FET Institute of Telecommunications associated professors (as it was mentioned before, 75% of all the teaching staff are associated professors of RTU FET Institute of Telecommunications, from other structures - 25%) are given below:

Oskars Ozoliņš, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. The research fields are digital signal processing with the help of photonics, components and systems for prompt short-range communication, optical wired and wireless interconnections, optical network monitoring and experience quality forecasting on the basis of machine learning. In his professional career, the associated professor O. Ozoliņš has been a guest researcher in III-V Lab (Nokia Bell Labs and Thales, France), Keysight Technologies (Böblingen Germany), DTU Photonics (Technical University of Denmark, Denmark), IDLab (Ghent University - imec, Belgium), OFO (KTH Royal Institute of Technology, Sweden) and PHOTO laboratory (University of Rennes 1, France). O. Ozoliņš is a foreign member of the Latvian Academy of Sciences. He is also an expert in the Committees of Technologies, Computer Sciences and Physics of the Latvia - Sweden Research Council. Expert of the Latvian Council of Sciences in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies, and in natural sciences - computer sciences and information sciences. He has more than 13 years of experience in advising students. He advised 36 bachelor's students, 23 master's students, 5 doctoral students and 3 post-doctoral students. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 19, co-author for 8 patents. Researcher or project manager in 8 projects in total. Assoc. professor O. Ozoliņš is a member of the EKG2022 Technical Programme Committee (TPC) in Basel, Switzerland and a member of OFC2023 TPC San Diego, California, USA.

Andis Supe, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Institute of Telecommunications, Telecommunication Network Group. Large scientific work experience in the field of fibre optical transmission systems. Participated in the successful implementation of many European Regional Development Fund (ERDF) and European Social Fund (ESF) projects and Latvian National Research Programme. In the period from 2018 until 2020, A. Supe implemented the post-doctoral project "RETUNE", which focused on signal regeneration using non-linear optical effects.

During the implementation period of the post-doctoral project, international research work experience was obtained at the Institute of Telecommunications of Aveiro University. A. Supe is a co-author of more than 30 international publications (Scopus data), co-author of 6 Latvian Patents and a member of the international IEEE conference MTTW TCP. He is involved in the Latvian Council of Science as an expert in electronics and telecommunications. A. Supe has more than 8 years of academic work experience teaching subjects at bachelor's, master and doctoral levels. 23 bachelor papers and 16 master papers are advised and defended.

Xiaodan Pang, Dr.sc.ing., guest associated professor, senior researcher, RTU, FET, Institute of Telecommunications. X.Pang is also a senior researcher at KTH Royal Institute of Technology, Applied Physics department, Stockholm, Sweden. Doctor's degree obtained in the Technical University of Denmark, Kgs. Lyngby, Denmark. Expert of the Latvian Council of Sciences in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies, and in natural sciences - computer sciences and information sciences. Co-author for 243 scientific publications available in the Scopus database, and his H-index is 22. Large experience in digital signal processing, multi-level modulations, radio-over-fibre, mm-waves and THz transmissions, coherent transmissions, Raman amplification, system simulation and laboratory equipment. He regularly reviews journals Optics Express, Optics Letters, IEEE/OSA Journal of Lightwave Technology, IEEE/OSA Journal of Optical Communications and Networking, IEEE Photonics Technology Letters, IEEE Photonics Journals, IEEE Journal of Quantum Electronics, Elsevier Optical Fiber Technology, Optics Communications etc. He advised 4 promotion works (2 are defended). He took part in the implementation of many research projects.

Aleksandr Shalin, Dr.sc.ing., associated guest professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. Assoc. prof. is the head of the "Nano-opto-mechanical" laboratory, senior researcher (associated professor) of the University of Information Technologies, Mechanics and Optics in Saint-Petersburg (ITMO). He advises nine promotion works (6 are defended) and is the senior researcher of five post-doctoral projects. Co-author in 177 scientific publications in Scopus database, H-index: 31, 2 patents. Scientific research fields: dielectric nanophotonics, theoretical near-field optics, nano object optics, plasmonics, optical properties in the heterogeneous environment and meta materials, optical transparency, anti-reflection coverages, meta surfaces, light-absorbing coverages.

The academic staff involved in the implementation performs scientific research at the international level by improving their own qualification and performing scientific and research activities (see CVs of the teaching staff). The academic staff have an opportunity to append professional knowledge and obtain valuable experience in one of the foreign higher educational institutions (using opportunities for mobilities of Erasmus or other projects), which is reconciled with the European education space development strategy, as well as to have traineeships in the enterprises.

In the implementation of the study course (lectures, practical works, laboratory works) the responsible teaching staff also attract candidates for the doctor's degree.

The RTU FET Institute of Telecommunications academic staff involved in the implementation of the master study programme "Telecommunication Technologies and Network Management" is highly specialized and with large scientific experience.

In total, the qualification of all members of the teaching staff corresponds to the implementation conditions and the normative acts of the study programme, as well as provides acquisition of study programme objectives and study results, which is proven by their qualification and curricula vitae.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

Both academic teaching staff and highly qualified experts from various fields are involved in the implementation of the study programme to make the implementation of the study courses of the programme as qualitative as possible.

In the implementation of the study programme 7 professors, 3 associated professors, 9 docents and 7 lecturers, 2 senior researchers (guest associate professors), and 1 scientific assistant are involved. Professors and associated professors are doctors of science, whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for a professor's position.

Analysing the changes, there are several reasons:

1. In the review period, associated professors and docents have raised their qualifications and became professors, or docents became associated professors;
2. The teaching staff took part in grant competitions, where received financing and an opportunity to make research in the field thus changing their academic position to the position of a senior researcher;
3. New experts in the field have been employed, and this promoted introduction of new technologies into study courses, therefore lecturers and assistants joined the implementation of the programme.
4. A part of the academic staff retired.

Almost in all groups of the teaching staff the average weighted age of the academic staff decreased.

Changes can be observed in the table below.

Table 4: Changes and the average age of the academic staff in the doctoral study programme

Teaching Staff	2013/2014		2020/2021	
	Number	Average age, years	Number	Average age, years
Professor	4	67	7	57
Asoc. professor	4	49	3	41
Docent	12	57	9	45
Lector	1	26	7	37
Senior researcher (guest asoc. professor)	-	-	2	34
Scientific assistant	-	-	1	26

Researcher	3	27	-	-
Total:	**24**	**45**	**29**	**40**

In the implementation of the programme new qualified teaching staff are involved, thus moving the content of the programme closer and closer to the specifics and the relevant topics of the field.

The basis of the selection and renewal of a qualification improvement policy of the academic staff is the regular involvement of master's students and master's study graduates and doctoral students in the study process. At the moment 5 faculty lectures are doctoral students, who promote the introduction of new learning methods as well as the relation of the study process with their own scientific research.

Currently, RTU implements the European Social Fund financed project SAM 8.2.2. "Strengthening of Riga Technical University academic staff in strategic specialisation fields", where one of the tasks is the renewal of the academic staff. The objective of the project is to strengthen RTU academic staff in strategic specialisation fields in 10 study directions. The project activities are in three directions:

- involvement of doctoral students in RTU academic work;
- the attraction of foreign academic staff to RTU;
- improvement of competencies of the existing academic staff, including traineeships of the academic staff in companies.

During the project, it is also possible for the academic staff to take professional English language courses and specialised courses.

The academic staff is stable and regularly takes part in various events related to the improvement of qualifications. Improvement of qualification is done by the academic staff through participation in academic and scientific conferences and seminars, and acquisition of various courses. The findings obtained during the improvement of qualification and during the scientific work are embedded into the learning process.

The teaching staff of the programme take part in local and international conferences, which is reflected in the curricula vitae of the teaching staff.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the

implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Mutual cooperation among members of the teaching staff is done within the study programme, starting from planning of the study year and reconciliation of the study course project tasks at regular methodological seminars, and continues within the whole semester through teaching the training courses, planning the necessary changes for each semester and for the programme in general.

Various cooperation channels are available for the academic staff:

- **Online conference platforms (ZOOM and MS Teams)** – technical support is provided for everyday cooperation – discussions, meetings and idea and opinion exchange;
- **E-Learning environment** – mutual cooperation of members of the teaching staff is provided, as well as cooperation with students of the study course. The main functions, which are provided by the E-Learning environment, study content management, assessment methods and management, communication with students, administration of tests;
- **Councils of structural units and institutes** – a specialised discussion of representatives of a certain field or the study programme about aspects, content, assessment methods, achieved results of study course implementation as well as discussion of other issues related to the implementation of the study programme;
- **Annual seminars and academic conferences** – the teaching staff discuss and share experience on the newest trends in study methods, and introduction thereof. Organised according to the needs.

Each year the study courses of the programme are regularly improved, based on both - recommendations from students and tendencies of the field. During the study courses, regular meetings and methodological seminars of the teaching staff are held, where experience exchange about study course topics take place, and also the content of study courses is elaborated and improved through mutual agreement on topics, directions, responsibilities and correspondence to the normative requirements. In the process, of course, reconciliation all members of the teaching staff are involved, who are taking part in the implementation of a certain study course, providing that the topics included in the study programme are continuously being improved and renewed in cooperation with the professionals involved in the field.

In planning and inclusion of new study courses into the study programme it is mutually reconciled that study courses do not overlap and provide students with the necessary knowledge in each field.

When reviewing and actualising a study programme, the teaching staff agree on the most applicable and efficient solutions with respect to the assessment of student achievements and the acquisition of results. When planning a study year and making an agreement on project tasks of the study courses, the disadvantages found before are taken into account and corrections are performed.

When analysing the ratio of students to teachers in the study programme, at the time of submission of self-assessment there are 3 students for one elected member of the teaching staff.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_EMC0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_EMC0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	Nr_38_RTU_mg_250_stud_Telekomunik.zip	Nr_38_RTU_mg_250_stud_Telekomunik.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EMC0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EMC0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_EMC0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_EMC0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EMC0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EMC0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EMC0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_EMC0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_EMC0(45526)_StudyCoursesdescr_ENG.zip	P10_EMC0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Information Technology Project management (47483)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Information Technology Project management*
Education classification code	*47483*
Type of the study programme	*Professional master study programme*
Name of the study programme director	*Jānis*
Surname of the study programme director	*Grabis*
E-mail of the study programme director	*grabis@rtu.lv*
Title of the study programme director	*Dr. sc.ing.*
Phone of the study programme director	*67089594*
Goal of the study programme	*To educate and train IT specialists competitive in the global labor market with in-depth knowledge in IT project management who are able to analyze, select, plan, create, integrate, implement and maintain user-friendly IT solutions for the achievement of business goals of companies and organizations.*
Tasks of the study programme	*• To provide in-depth knowledge in information technology. • To provide knowledge and skills specified in the information technology project manager professional standard. • To prepare students for successful professional career and to train professionals requested by the industry. • To develop individual talents of students and to provide stimulating studying experience and environment. • To nurture recognition of the need for and an ability to engage in continuing professional development. • To foster research and development activities and to promote academia and industry collaboration. • To develop a sense of professional ethics and responsibility among students. • To promote critical and systems thinking and to develop organizational, collaboration and cooperation skills. • To explain and to promote information technology in the society. • To develop the ability to work and cooperate within self-organized teams.*

Results of the study programme	*• an ability to plan and execute information technology projects; • knowledge of development processes and technologies; • an ability to select, evaluate and implement information technologies needed by users; • an ability to synthesize and to implement project management best practices at enterprises and organizations; • an ability to perform client-centric analysis and new product development and service design; • an ability to analyze systems, document processes and identify improvement opportunities; • an ability to communicate with all project stakeholders and to present the project results; • an ability to plan and to manage change processes to achieve enterprise objectives; • an ability to systematically research information technology problems; • an ability to select, evaluate and use suitable digital solutions for project management.*
Final examination upon the completion of the study programme	*Master Thesis with a project qualification part.*

Study programme forms

Full time studies - 1 years, 6 months - latvian

Study type and form	*Full time studies*
Duration in full years	*1*
Duration in month	*6*
Language	*latvian*
Amount (CP)	*60*
Admission requirements (in English)	*1) professional bachelor's degree in information technology, computer systems, electronic commerce, electronic business or 2) bachelor's degree of natural sciences in computer science or compatible education obtained in four-year studies.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Information Technology*
Qualification to be obtained (in english)	*Information Technology Project Manager*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years, 6 months - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*6*
Language	*latvian*
Amount (CP)	*100*

Admission requirements (in English)	*bachelor's degree, if the applicant has acquired study courses in the field of natural sciences and information technology in the volume of at least 20 CP within a study program and/or as a listener.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Information Technology*
Qualification to be obtained (in english)	*Information Technology Project Manager*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*bachelor's degree in information technology, computer management and computer science, computer systems, computer science, or equivalent education.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Information Technology*
Qualification to be obtained (in english)	*Information Technology Project Manager*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The name of the study program, the degree to be obtained, the professional qualification the aims, tasks, learning outcomes and admission requirements of the study program are mutually coordinated. Since the previous issuance of the accreditation page of the study field, several changes have been made to the parameters of the study program with the aim to improve the compliance of the study program with the needs of the industry, as well as to improve its quality. During the reporting period, changes have been made to the following parameters of the study program – change of the name, change of classification code, changes in implementation options and admission requirements.

The title of the study program has been changed from “Information Technology” to “Information Technology Project Management”. The changes have been implemented in order to ensure that the title of the study program more accurately reflects the aims of the program and the competencies to be acquired, as well as to indicate the link with the professional standard “Information Technology Project Manager” and the professional qualification to be acquired as a result of studies.

The implementation of the study program has been expanded to offer 3 (three) different implementation variants with different duration, volume (number of credit points (hereinafter - CP), and admission requirements, changes have been made to the volume of the existing variants and admission requirements. The study program is offered in the following variants:

- Variant 1 (100 CP, duration 2.5 years).
- Variant 2 (60 CP, duration 1.5 years). Changes in the volume of the variant have been made during the reporting period – the volume has been reduced from 62 CP to 60 CP. The changes have been implemented due to consolidation of study courses in Part A of the program (combined content-wise similar courses, see section 3.2 for more details on the structure of the courses).
- Variant 3 (80 CP, duration 2 years). A new version has been created.

In the previous period, there were two options for the implementation of the study program (Variants 1 and 2). Variant 1 has been modified to provide broader access to higher education for those who have previously completed education in another thematic group and/or field. The target groups of Variant 1 for the implementation of the study program are specialists working in the IT sector with education in another field (for example, management, entrepreneurship), as well as representatives of other industries who want to retrain and start a career in the IT sector. Currently, the mentioned target groups are primarily offered non-formal education in the IT sector (continuing education courses, etc.); expanding the study offer would promote the IT skills of the workforce, which is a strategic priority at the European level, reduce potential unemployment risks, as well as reduce the shortage of IT specialists in the Latvian and European labor market. The list of compulsory study courses in Variant 1 also includes study courses covering the basics of the IT sector. Variant 3 is intended for applicants with an academic Bachelor's degree in information technology, who require to undertake a larger volume of an internship than students enrolled in Variant 2.

Changes have also been made to the admission requirements (requirements towards previously acquired education):

- Variant 1 (100 CP, duration 2.5 years) – applicants need a Bachelor's degree if they have acquired study courses in the field of natural sciences and information technology in the volume of at least 20 CP in the study program and/or as a listener.
- The conditions for admission to Variant 2 (60 CP, duration 1.5 years) have been supplemented. Previously, admission required a professional Bachelor's degree in information technology, computer systems, electronic commerce, electronic business, or compatible education. The requirements have been extended by stipulating that the students with a Bachelor's degree in natural sciences obtained in four-year studies or an education compatible thereto can also be enrolled in this program variant.
- The conditions for admission Variant 3 (80 CP, duration 2 years) have been formulated anew – Bachelor's degree in information technology, computer management, and computer science, computer systems, computer science or compatible education.

The changes have been implemented with an aim to broaden the range of persons to be admitted and to offer higher education opportunities to the above-mentioned target groups. The competencies defined in the professional standard “Information Technology Project Manager” are related to different thematic groups/areas of education (e.g., management, psychology, economics), thus, the admission requirements should also be expanded.

The classification code of the study program has been changed. During the previous accreditation period, the study program code was 47481. The change of this code is provided for in the Cabinet Regulation No. 322 of 13 June 2017. The most appropriate code for the study program is Computer Systems, Databases, and Computer Networks code 47483. Information technology project management covers various ICT industry projects and looks at different ICT solutions in general, creating complex engineering computer systems.

In accordance with industry trends, as well as student recommendations for improvement of the curriculum of the program, almost every year changes are made to the curricula of the study courses and the content of the program. The curricula of study courses are regularly reviewed, analyzed, and improved, existing study courses are supplemented and updated, and the latest teaching methods and scientific research results are integrated into them. Changes in the curricula and volume of the study courses have also been implemented in the study program in accordance with the requirements of the updated version of the professional standard “Information Technology Project Manager” in 2022. More detailed information on the study courses included in the program is provided in Section 3.2.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program is implemented in the field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” The professional qualification “Information Technology Project Manager” to be obtained as a result of studies is in accordance with the requirements of the respective professional standard, which is included in the qualification structure of the sector | Electronic and optical equipment production, information, and communication technologies.”[1].

The title of the study program, “Information Technology Project Management” precisely characterizes the study field, the aim and learning outcomes of the study program. The aim of the study program is to educate and train IT specialists competitive in the global labor market with in-depth knowledge in IT project management who are able to analyze, select, plan, create, integrate, implement and maintain user-friendly IT solutions for the achievement of business goals of companies and organizations. Most graduates of the study program work as IT project managers or in related professions, such as system analysts, information security engineers (see Section 3.1.3). The study program code is 47483 in a set of educational programs in Computer systems, databases and computer networks. The study program has been developed in accordance with RTU strategic specialization in engineering and technology, highlighting the creation of complex engineering computer systems.

The study program has been developed in accordance with the Vocational Education Law and its content is regulated by the state vocational education standard, the standard of the profession “Information Technology Project Manager”, as well as the description of the qualification structure of the sector “Manufacture of Electronic and Optical Equipment, Information and Communication Technologies”2. The degree and qualification to be obtained as a result of studies is the Master's Degree in Engineering Sciences in Information Technology and the qualification of the information technology project manager. Engineering is characterized by a set of scientific principles that can be applied in practice with the aim of inventing, constructing, maintaining or improving various structures, systems, machinery, equipment, materials and production processes. The field of engineering is divided into several industries and typical engineers specialize in one or thematically related industries. One of the sectors is information technology. the field of information technology project management is characterized by the application of methods, tools and methodologies in the management of information technology solution development, implementation and maintenance projects in order to achieve the goals of the organization. In order to meet qualification requirements in information technology project management, the learning outcomes cover the acquisition of best practices in information technology project management and the development of information technology project planning and implementation skills using digital solutions.

The study program is implemented in three different variants: Variant 1 (100 CP, duration 2.5 years), Variant 2 (60 CP, duration 1.5 years) and Variant 3 (80 CP, duration 2 years). The duration of the study program is appropriate for the achievement of its goal to educate and train information technology specialists competitive in the global labor market with in-depth knowledge in IT project management. The implementation of the study program is offered in three different variants, which are aligned with the existing competencies and experience of future specialists. After professional Bachelor's studies or after four-year studies that resulted in obtaining a Bachelor degree in natural sciences or compatible education, specialists working in the field are offered a shorter period of time for the acquisition of the program (1.5 years), other applicants have to study for longer periods (2 or 2.5 years depending on the previously acquired education). Variant 2 provides an additional semester for professional internship. Variant 3 provides for an additional semester for the acquisition of fundamental study courses in the field and an additional study project. This approach integrates the principles of student-centeredness, which help to focus on the competences to be developed by students and allow students to obtain a degree and qualification in different time periods.

Admission to the study program is implemented in accordance with the regulations “Admission Regulations for Higher Level Academic and Professional Study Programs” approved by the RTU Senate Decision No. 655 from the regulations “Admission Regulations for Academic and Professional Post-Graduate Study Programs” on 25 October 2021. In the 1st variant of the study program (100 CP, duration 2.5 years), students with a Bachelor's degree in computer management and computer science or compatible education are admitted. In the 2nd variant of the study program (60 CP, duration 1.5 years), students with 1) professional Bachelor's degree in information technology, computer systems, electronic commerce, electronic business or 2) Bachelor's degree of natural sciences in computer science or compatible education obtained in four-year studies are admitted. In the 3rd variant of the study program (80 CP, duration 2 years) students with a Bachelor's degree are admitted, if the applicant has acquired study courses in the field of natural sciences and information technology in the volume of at least 20 CP within a study program and/or as a listener. 20 CP is the amount consistent with globally accepted practice on the minimum amount of knowledge required to obtain a degree in different sectors. The conditions of admission provide an opportunity to apply for the study program to the specialists with different types of previously acquired education, while at the same time determining the mandatory requirements for the acquisition of basic information technology courses. This contributes to an increase in the number of IT graduates, which is in line with the strategic and policy objectives of Latvia and Europe (see 3.1.3). Admission takes place on a competitive basis, and the weighted average grade of applicants in undergraduate studies is evaluated. In addition, individual discussions are carried out with the applicants in order to evaluate the previously acquired competencies and recommend them the most appropriate study program implementation variant.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Information technology is one of the most significant and fastest growing sectors of the Latvian economy, which constantly needs new specialists. The importance of IT skills and capabilities is highlighted in both Latvian and European strategic planning documents. Skills and capabilities are needed to implement digital transformation initiatives, including digitization project management, where IT solutions are designed, developed, or maintained.

The National Development Plan of Latvia for 2021-2027 states that ICT achievements and their wide availability are a catalyst for changes in the economy, public administration, and society as a whole. The knowledge society, thanks to the targeted application of ICT solutions, transforms the existing and creates new processes, business models, habits, and culture in all spheres of the economy and life. Digital transformation is the key to productivity, economic growth, and the well-being of the individual and society. In 2019, in the survey of the heads of industry associations conducted by LIKTA [1], 92% of respondents admitted that the digitization processes taking place in society would have a large or partial impact on the companies they represented, while only 8% of the heads of associations admitted that companies in their industries carried out a full digital transformation. This indicates that the digital transformation will be relevant in the coming years. Digital transformation, including implementation, development, and maintenance of various IT solutions is typically carried out in the form of IT projects.

Latvia’s Smart Specialization Strategy for Research and Innovation (RIS3) highlights the goal set by the state to achieve higher productivity and create more valuable products. Innovation is a way to achieving this goal. The state has identified five areas of knowledge where competences for the creation, production and sale of new products and technologies and additional research are currently most needed. Information and communication technologies are one of the four areas. The Informative Report of the Ministry of Education and Science of the Republic of Latvia "Smart Specialization Strategy Monitoring System" identifies several directions of economic transformation and growth priorities, which justify the importance of the field and the need for IT specialists in the future, including priority 6 "Developed knowledge base and human capital in knowledge areas where Latvia has comparative advantages and which are related to the needs of knowledge-intensive development of ICT industries".

The importance of the in-depth use of digital skills and a wide range of digital capabilities is also highlighted by the European Union's Digital Europe program and the planned Programs of European Funds. For example, within the framework of the European Recovery Fund (ERF), Latvia has funding in the amount of EUR 1.82 billion and more than EUR 365 million is to be invested in digitalization activities, which is 20% of the total funding of the ERF, providing support measures both for the provision of 5G infrastructure and for the improvement of the basic digital skills of the population, the development of public platforms and state IT systems, as well as EUR 140 m of the total amount of funding is earmarked for the digital transformation of entrepreneurship and improvement of digital skills. Minister of Economics of the Republic of Latvia Jānis Vitenbergs emphasizes, "*The period of the COVID-19 pandemic has shown that we need to invest vitally in the digitalization of companies and various processes, which would allow us to adapt more flexibly to different situations and mitigate potential negative shocks in the future. Appropriate ICT solutions and innovations have gained a special place in the daily lives of both businesses and citizens.*"

There is a critical shortage of IT specialists in the current working environment and their shortage and demand continue to grow. The National Development Plan "Digital Transformation Guidelines 2021-2027" emphasizes that the low share of its specialists' workforce in the country hinders digitalization and productivity The CV-online database [2] currently lists more than 900 vacancies in the IT sector (data as of 16 March 2022). CSB data indicate that every year about 700 young specialists complete their studies in the field of information technologies, while the industry survey "Future goals, present directions" conducted by the think tank Certus in 2017 Latvia 2022" revealed that the Latvian IT industry needs up to 3,000 new graduates per year. The long-term labor market forecasts of the Ministry of Economics, covering the employment needs of sectors by occupation and education up to 2040, envisage wider use of various technologies and innovations in everyday life, and thus also the demand for qualified information technology specialists.

This demonstrates the continued need to train competitive information technology specialists. In order to manage digital transformation projects, in-depth knowledge of IT project management is required. IT project managers must be able to analyze, choose, plan, create, integrate, implement and maintain user-friendly information technology solutions for the achievement of business goals of companies and organizations. This is the aim of the study program.

Alumni of the study program work in information technology companies in Latvia and worldwide, as well as in companies that use complex information technology solutions. The most important employers are Accenture, Tieto, Latvenergo, TET, Printful, Emergn, and Visma. Primarily graduates work as IT project managers, professions in specializations such as SCRUM team captains, or related professions, such as IT consultants, system analysts, IT security managers or product managers.

RTU alumni monitoring data indicate that 91% of graduates in natural sciences, mathematics and IT are employed and graduates in this field have the highest level of remuneration compared to other fields of study at RTU (Figure 1). Data of the portal Algas.lv indicate that the average net monthly salary of an IT project manager is 2000 EUR [3] (data as at 16 March 2022). In the IT sector, specialists with the highest qualification are particularly important due to the high complexity of the systems they deal with. IT specialists who have obtained a Master's degree earn 20-25% more than the specialists who have acquired basic education (https://www.cv.lv/). Leading professionals also have a higher employment rate.

There is an even smaller number of unemployed among the graduates of the study program (compared to the field of study discussed above, which includes several programs). Approximately 93% of the graduates of the study program are employed, only 1.18% are unemployed and 3.53 % are inactive for other reasons, 2.35% of graduates have emigrated or there is no available information about them (CSB data [4] on employment among graduates of the higher education institutions in Latvia in 2017 and 2018).

[1] IKT izglītībai un digitalizācijai - Kampaņa «Gudrā Latvija» | LIKTA

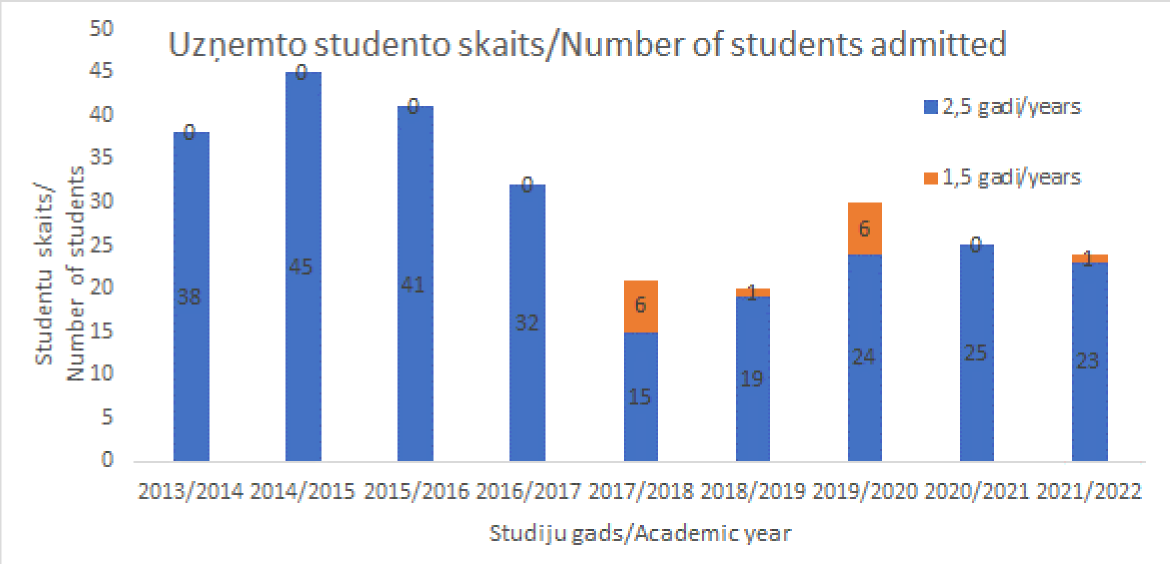
[2] Sākums | CV-Online - darba piedāvājumi, vakances, CV, personāla atlase

[3] Alga Latvija, IT projektu vadītājs, Informācijas... (algas.lv)

[4] Latvijas augstākās izglītības iestāžu 2017. un 2018.gada absolventi; 2018. un 2019. taksācijas/monitoringa gados - Latvijas augstākās izglītības iestāžu 2017., 2018. gada absolventi 2018. un 2019. monitoringa gados - Latvijas Atvērto datu portāls (data.gov.lv)

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

During the reporting period from academic year 2013/2014 to 2021/2022, the number of students has varied with a tendency to decrease. The trend is in line with the overall trend in the European Union – the number of Master's students is decreasing. During the reporting period, there were on average 95 students in the program. Between 20 and 45 are enrolled in the study program each year (see figure below). The number of students enrolled varies for various reasons, the most important of which are demographic trends, the overall decrease in the number of students in the country, as well as the early employment of students (students in the field of information technology typically start their work while studying at the Bachelor's programs). Over the last five years, the trend in enrolments has been steady, with an average of 24 students enrolled per academic year. It is planned to increase the number of students by offering several options for the implementation of the study program (see Section 3.2.1).



During the reporting period, the number of graduates varies from 11 to 23. On average, 18 alumni graduate from the program, which is on average 60% of the average number of enrollees. The biggest drop-out of students is observed in the 1st year of studies and the most common reason for student deduction has been academic failure. The proportion of alumni depends on a variety of circumstances, including the employment already mentioned, which tends to have a negative impact on the proportion of graduates. In the last 2 years, the COVID-19 pandemic has also had a negative impact, as a result of which students' motivation has deteriorated.

During the reporting period, all students have been admitted to state budget-funded seats. All students are studying in a full-time program, it is the only form of study implemented during the reporting period. Most of the students in the study program are employed, therefore in recent years the study time has been adapted to the needs of students – 80% of the study courses are offered after 16.30 o'clock.

The study program is implemented only in Latvian, therefore, the share of international students is relatively small - less than 0.8%.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether

the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The objectives, tasks, designed curriculum of the study program and methods of its implementation are in line with the current trends in the field, technology and sustainable business development. All study courses included in the study program are connected to the objectives, tasks and results to be achieved by the study program. Upon completion of the study courses, students must acquire the knowledge, skills and competences determined by the professional standard “Information Technology Project Manager” (mapping the curriculum of the study program with the knowledge defined in the standard is provided in the Annex “P07_3.2.1_DGI0(47483)_AtbProfStand_LV_ComplOccupationalStand_ENG”). The study program is implemented in 3 variants with different volume in credits and duration. A consolidated overview of all implementation variants is given below. Descriptions of the study courses can be found in Annex.

The volume of Variant 1 of the study program is 100 CP, of which 26 CPs are compulsory study courses and 24 CP compulsory elective study courses (of which 20 are professional specialization study courses and 4CP – study courses on economics and management). 26 CP consists of internship and 26 CP final state examination – Master’s Thesis with the project part. The volume of Variant 2 of the study program is 60 CP, of which 16 are compulsory study courses and 18 CP compulsory elective study courses (of which 14 are professional specialization study courses and 4 CP – study courses on economics and management). 6 CP consists of internship and 20 CP final state examination – Master’s Thesis with the project part. The volume of Variant 3 of the study program is 80 CP, of which 16 are compulsory study courses and 18 CP compulsory elective study courses (of which 14 are professional specialization study courses and 4 CP – study courses on economics and management). 26 CP consists of internship and 20 CP final state examination – Master’s Thesis with the project part. The different variants of the study program and their volume are based on the typical profiles (competencies and practical experience) of the target audience (students) of the program.

Compulsory study courses of the study program offer in-depth theoretical knowledge in information technology project management, as well as promote the development of research skills necessary for obtaining a professional Master’s degree. All variants for the implementation of the study program shall include the following compulsory courses (Part A):

- DOP731 Information Technology Projects Management (4 CP)
- DOP500 System Analysis and Design (4 CP)
- DOP732 Information Technology Project Planning (Study Project) (4 CP)
- DMI670 Information Technology Governance (4 CP)

Variant 1 of the study program implementation in Part A additionally includes study courses that form the foundations of information technology - DIP107 Algorithmization and Programming of Solutions (Part 1) (3 CP), DSP201 Database Management Systems (4 CP) and DOP319 Computer Networks (3 CP). The acquisition of the abovementioned study courses is important for students in the 1st version of the study program implementation, because the requirements for the admission of this variant do not provide for the previously acquired education in the fields of information technology or computer science. But fundamental knowledge is critical for successful implementation of work in the profession of IT project manager, which is also indicated by the standard of the profession.

During studies, three study projects should be developed, one of which may be a study project developed during undergraduate studies. The compulsory part of the study program includes the study project DOP732, but the compulsory elective part includes study projects DOP730 and DOP735. Students of Variant 2 and 3 must choose at least one of these study projects. Students within the 1st program variant must choose both study projects, it is also possible to acquire one of the study projects in the professional study program of a programming engineer.

Professional specialization study courses form a knowledge base for the application of information technology for the implementation of business goals; this means that alumni are able to solve business problems and promote the implementation of new opportunities using IT solutions. It also includes study courses for the in-depth acquisition of individual issues of project management. All study program implementation options include the following study courses of professional specialization (Part B, Section B1):

- DOP730 Enterprise Change Programme (study project) (4 CP)
- DOP735 Data Governance Study Project (4 CP)
- DMI728 Data Mining and Knowledge Discovery (4 CP)
- DOP458 Project Risk Management (3 CP)
- DOP420 Project Management Tools (2 CP)
- DOP723 Digital Transformation (4 CP)
- DOP724 Data Integration Technologies (2 CP)
- DMI463 Electronic Commerce (2 CP)
- DOP728 Information Security and Personal Data Protection (3 CP)
- DSP424 Large Databases (3 CP)
- DMI470 Logistics Information Systems (3 CP)
- DPI551 Object-Oriented System Analysis (3 CP)
- DOP465 Enterprise Resource Planning Systems (3 CP)
- DOP514 WEB Programming (2 CP)

The volume of study courses to be completed within implementation variants. Variant 1 requires professional specialization courses of 20 CP, while Variants 2 and 3 require 14 CP. This is due to the different admission requirements (prior education of students).

Study courses in economics and management, as well as humanities and social sciences promote the current competences of the 21st century, such as learning and improving independently, thinking critically and creatively, reflecting on own performance. All program variants include the following humanitarian and social study courses (Part B, Section B2):

- HSP484 Psychology (2CP)
- HSP446 Pedagogy (2CP)
- HFL433 Presentation Skills (2CP)
- IUV305 Personnel Management (basic course) (2CP)
- IUV456 Accounting and Finances (2CP)
- IUE308 Entrepreneurship Planning (2CP)

Part D Internship and Part E Final / State Examination of the study program focus on students' ability to independently improve their development and self-education in the field of information technology project management, to practically plan and implement IT projects, as well as to initiate scientific research.

The compulsory and compulsory elective parts of the study program include study courses dedicated to the study of theoretical knowledge of the information technology sector and approbation of theoretical knowledge, as well as study courses dedicated to scientific research methods in the amount of 18 CP. Increased attention is paid to research methods within such courses as DOP500 System Analysis and Design, DMI670 Information Technology Governance and DOP723 Digital Transformation, where the curriculum is acquired in the research-based mode. Within these courses, such research methods data analysis, experimental, summarizing and case study analysis are considered, respectively. Within the courses DOP731 Information Technology Projects Management, DOP732 Information Technology Project Planning (Study Project), DOP730 Enterprise Change Programme (study project), DOP735 Data Governance Study Project and DPI551 Object-Oriented System Analysis special focus is made on the in-depth acquisition of the newest achievements in the IT theory and practice.

The aim of the program is to educate and train IT specialists competitive in the global labor market with in-depth knowledge in IT project management who can analyze, select, plan, create, integrate, implement and maintain user-friendly IT solutions for the achievement of business goals of companies and organizations. To achieve the aim, several tasks of the study program have been defined, as well as the characteristics of their implementation. They are presented in the following table:

No	**Task**	**Performance characteristics**
1.	To provide in-depth knowledge in information technology	A high level of knowledge in information technology is ensured by combining the knowledge and skills provided in compulsory (Part A) and compulsory elective (Part B) study courses with the practice acquired in laboratory work and projects, internships in enterprises, as well as providing research skills in the process of developing the graduation paper.
2.	To provide knowledge and skills specified in the information technology project manager professional standard	The study program curriculum has been updated in accordance with the requirements of the standard of the profession of information technology project manager (see mapping in Annex "P07_3.2.1_DGI0(47483)_AtbProfStand_LV_ComplOccupationalStand_ENG").
3.	To prepare students for successful professional career and to train professionals requested by the industry	Students are prepared for a successful professional career, which is ensured thanks to the application of the knowledge acquired during their studies in laboratory works and projects and internships in enterprises. Internship is an integral part of the study program; it is aimed at improving the professional skills and competencies of the students in a professional environment, as well as strengthening and supplementing their knowledge in accordance with the requirements included in the IT project manager's standard (see Section 3.2.4 for more detail). Graduates of the study program demonstrate a high employment rate (see Section 3.1.4 for more detail).

No	Task	Performance characteristics
4.	To develop individual talents of students and to provide stimulating studying experience and environment	The study program includes both compulsory (Part A) and compulsory elective courses (Part B), the combination of which allows a particular student to adapt the program they have acquired according to their own wishes, and market requirements and to develop individual abilities. A stimulating study environment is created both by independently aligning the content of the study program with industry trends and by offering students individual study plans, for example, crediting MOOC courses.
5.	To nurture recognition of the need for and an ability to engage in continuing professional development	Students' desire to independently improve their knowledge is encouraged both by the themes and insights included in various study courses, as well as by the graduation paper, which is developed as a scientific research work. The importance of professional development is communicated in several study courses. For example, the study course DOP731 Information Technology Project Management (4CP) emphasizes the importance of teams and individual values, including growth thinking as a critical prerequisite for team management. The graduation paper is developed in close cooperation with the scientific supervisor of the work, thus paying special attention to a specific field of research chosen by the student themselves. Thus, the student's research interest and initiative are particularly supported.
6.	To foster research and development activities and to promote academia and industry collaboration	The staff of the study program unite academic staff with professionals in the field (see Section 3.4 for more detail). This ensures the integration of scientific and industry knowledge and trends in the study process. Cooperation with companies is implemented in the updating of the study program, implementation of study courses, and development of graduation papers and internship. During the reporting period, the study program has been updated to bring it in compliance with the related professional standard, the updating of which has been attended by representatives of leading IT industry companies, including Accenture, Proof IT, Visma, Emergn, DIVI group, representatives of consulting companies - KPMG and representatives of large companies - LMT. Thus, the content of studies that meets the requirements of companies is ensured. Representatives of companies are attracted to the implementation of study courses, for example, consultants of the company Accenture participate in the study course DOP732 Information Technology Project Planning (Study Project) (4 CP). Cooperation with entrepreneurs takes place both during the internship and in the development of graduation papers, where industry problems are typically addressed (see Section 3.2.6 for more detail).
7.	To develop a sense of professional ethics and responsibility among students	Professional ethics is acquired both in humanitarian and social study courses (Part B), as well as during student internship at the enterprises.
8.	To promote critical and systems thinking and to develop organizational, collaboration and cooperation skills;	The approach of critical and systematic thinking is developed by combining the knowledge and skills provided within the framework of various courses with the practice acquired in laboratory works and projects, as well as by providing research skills in the process of developing the graduation paper. Collaboration skills are developed in group work (see Description of Performance of Task 10).

No	Task	Performance characteristics
9.	To explain and to promote information technology in the society	The role of information technology in society is emphasized in several study courses, for example, DOP732 Information Technology Project Planning (Study Project) (4 CP) and DOP723 Digital Transformation (4CP). Students promote the role of IT when writing scientific articles on certain topics, for example, several student articles on the use of technologies in solving societal problems have been developed and published within the study course DMI670 Information Technology Management (4CP). The field is also promoted in the process of drafting graduation papers, as well as applying the acquired knowledge in practice.
10.	To develop the ability to work and cooperate within self-organized teams	The study program includes several study courses, where group work is implemented that develops students' ability to cooperate and self-organize. For example, group work is widely used in the following study courses: DOP731 Information Technology Project Management (4CP), DOP500 Systems Analysis and Design (4CP), DOP732 Information Technology Project Planning (Study Project) (4 CP), and DOP730 Enterprise Change Programme (Study Project) (4 CP).

Current trends in information technology are increasing the efficiency of IT product and service delivery processes, data analytics and management, business process analysis and automation, use of innovative technologies in the processes, products, services, information security and development of software engineering technologies (see trend characteristics in Section 3.2.6). Current trends in information technology project management are determined by international standards and compilations of best practices, for example, the project management standard updated by the Project Management Institute in 2022, which is described in the PMBOK guidelines. Version 7 differs significantly in its content and structure from the previous versions. Previous versions of the standard focused primarily on the traditional delivery models (waterfall model), while the 2022 version covers different delivery models (traditional, ability driven, hybrid models). The standard determines the need to know various methods and models of problem research, process management and team management (for example, design thinking, Lean, ADKAR, Kotter 8 steps, Cynefin, etc.). In accordance with the recommendations of PMBOK and industry experts, the professional standard "Information Technology Project Manager" has also been renewed in 2022 (the updated standard is in the approval stage). The compliance of the study courses with labor market and scientific development trends is carried out at the level of updating of study courses at the level, selection of the topic of study papers, and changes in the study program. During the reporting period, significant changes have been made to the curriculum of the study program, the most significant of which are:

- Several new study courses have been created, including:
- Study course DOP731 Information Technology Project Management (4CP), which replaced the study course DOP422 Information Technology Project Management (2 CP). The content of the study course has been expanded, it covers various delivery models (waterfall, fast delivery, hybrid models) and its content is aligned with the performance areas defined in version 7 of PMBOK. The content of the study course includes industry trends related to the supply of services and products (DevOps and SRE approaches, etc.). The study course integrates various methods and models of problem research, process management, and team management (design thinking, Lean, etc.).
- Study course DOP735 Data Governance Study Project (4 CP), the content of which covers the

industry trends not previously addressed in the study program - data analytics and management. The aim of the study course is to study data-based information system and solution development processes and project management, and data product management.

- Study course DOP730 Enterprise Change Programme (Study Project) (4CP), which replaced the study course DOP407 Restructuring and Change Management (3 CP). The content of the study course includes industry trends related to the supply of services and products (product management, etc.). The study course integrates various methods and models of problem research, process management, and team management (Kotter's Steps 8, ADKAR, etc.).
- The content of the study courses has been updated and content-wise similar study courses have been joined. For example, the study course DOP728 Information Security and Personal Data Protection integrates the content of the study course DOP318 Information Systems Safety (2 CP), avoiding the overlapping of content.
- Several study courses were excluded, the content of which did not make a significant contribution to the achievement of the aims and tasks of the study program, for example, DMI458 Analysis and Management of Logistics Chains (3 CP), DOP415 Operational Systems and Strategies (3 CP), and DMI544 Software Development Technology (2 CP).

Renewal of the curricula of study courses is carried out in accordance with RTU regulations. If significant changes are made to the curriculum, then they are reviewed by the Committee of the field Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science, which also includes representatives of the industry. Operational changes are made by drawing up the calendar plan for the current semester. The FCSIT Methodical Committee is in place to examine the current issues. The faculty seminar examines questions about the digitization of the study process, the use of modern study methods, evaluation of learning outcomes and academic integrity.

Industry trends are also reflected upon with the help of industry representatives, who participate in the implementation of the study courses, for example, for several years consultants from Accenture participate in the delivery of the study course DOP732 Information Technology Project Planning (Study Project) (4 CP) and representatives of various companies and organizations participate in the evaluation of study papers: Accenture, Latvenergo, Luminor, SAP, Latvian National Project Management Association, etc. Accenture awards cash prizes to the best teams. The study courses use the latest software and methodological materials offered by academic collaboration programs of large IT companies, such as Microsoft Academic Alliance, SAP University Alliance, and Tableau. The most popular tools are used within the study courses, for example, in the study courses DOP731 Information Technology Project Management (4CP), DOP732 Information Technology Project Planning (Study Project) (4 CP), and DOP420 Project Management Tools (2CP) the Atlassian tools are widely used – JIRA, Confluence, Trello, which are the most popular in IT project management.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The study program offers higher professional education, which provides a high level of knowledge in information technology and in-depth knowledge in IT project management. The acquired education ensures the competencies corresponding to the requirements in the profession of IT project manager, as well as allows graduates to perform scientific research work, to hold the position of a researcher and to continue studies in PhD studies.

The aim of the study program is to educate and train information technology specialists competitive in the global labor market with in-depth knowledge in IT project management who are able to analyze, select, plan, create, integrate, implement and maintain user-friendly information technology solutions for the achievement of business goals of companies and organizations. To reach these aims, several tasks have been set for the study program, including the task of promoting the introduction of the latest scientific and technical knowledge in the study process and cooperation with enterprises. The task is fulfilled by incorporating the latest scientific achievements into the curricula of the study courses, implementing research within the framework of study courses, involving students in scientific research projects, and conducting research during the development of study papers. Scientific research is mainly carried out in such sectors of electrical engineering, electronics, information, and communication technology as systems analysis, modeling, and design.

The most important research areas in which students are involved in are:

- Digitalization and digital service ecosystems;
- Use of innovative technologies in processes, products, and services;
- Increasing the efficiency of IT product and service delivery processes;
- Information protection and cybersecurity.

In these areas, international and national research projects are implemented, such as:

- Practical research program project “Platform for COVID-19 for Safe Working Environment”, 2022 - 2023;
- VPP-COVID-2020/1-0009, National Research Program project “Prospective Technologies for Safe and Resilient Services, 2020”;
- European Commission FP7 project No. 611351 “Capability as a Service in Digital Enterprises”, 2013-2016.

In the international evaluation of scientific institutions in 2019, FCSIT received a rating of "4" out of "5". The evaluation highlighted in particular the contribution to economic development. The high evaluation confirms the high scientific potential of academic staff of FCSIT and the study program the development of which is also promoted by Master's studies. During their studies, students develop scientific publications, which are also indexed in international bibliographic databases, for example:

- Kampars, J., Grabis, J., Matisons, R., Vindbergs, A. On Integration of Evolving Infrastructure Topology Graphs and Metric Data Streams in Information Technology Infrastructure Management. In: Environment. Technology. Resources: Proceedings of the 13th International Scientific and Practical Conference. Vol.2, Latvia, Rēzekne, 17-18 June, 2021. Rezekne: Rezekne Academy of Technologies, 2021, pp.62-68;
- Deksne, L., Grabis, J., Žeiris, E. Towards Data Ecosystem Based Winter Road Maintenance ERP System. In: Perspectives in Business Informatics Research: 20th International Conference on Business Informatics Research (BIR 2021): Proceedings. Lecture Notes in Business Information Processing. Vol.430, Austria, Vienna, 22-24 September, 2022. Cham: Springer Nature Switzerland AG, 2021, pp.69-83;
- Grabis, J., Kampars, J., Pinka, K., Mosāns, G., Matisons, R., Vindbergs, A. Solutions for Monitoring and Anomaly Detection in Dynamic IT Infrastructure: Literature Review. In: 11th International Conference on Cloud Computing and Services Science (CLOSER 2021):

Proceedings, Czech Republic, Prague, 28-30 April, 2022. Setúbal: SciTePress, 2021, pp.224-231;
- Deksne, L., Vempers, J., Kampars, J. Technology Selection for Development of Intellectual Road Maintenance Platform. In: *2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS 2021): Proceedings*, Latvia, Riga, 14-15 October, 2021. Piscataway: IEEE, 2021, pp.1-6;
- Kampars, J., Matisons, R., Tropins, D. A Review of Application Layer Communication Protocols for the IoT Edge Cloud Continuum. In: *2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS 2021)*, Latvia, Rīga, 15-15 October, 2021. Piscataway: IEEE, 2021, pp.1-6.
- Skrebeca, J., Kalniete, P., Goldbergs, J., Pitkevica, L., Tihomirova, D. & Romanovs, A. 2021, "Modern Development Trends of Chatbots Using Artificial Intelligence (AI)", ITMS 2021 - 2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University, Proceedings.
- Bērziša, S., Bravos, G., Cardona Gonzalez, T., Czubayko, U., Espana, S., Grabis, J., Henkel, M., Jokste, L., Kampars, J., Koc, H., Kuhr, J., Llorca, C., Loucopoulos, P., Pascual, R., Pastor, O., Sandkuhl, K., Simic, H., Stirna, J., Valverde, F., Zdravkovic, J. Capability Driven Development: An Approach to Designing Digital Enterprises. Business & Information Systems Engineering, 2015, Vol.57, Iss.1, pp.15-25

In order to create a conductive scientific environment, the Institute of Information Technology publishes a collection of articles “Information Technology and Management Science”, organizes the annual international scientific conference “IEEE Information Technology and Management Science Conference” (http://itms.rtu.lv/), the institute’s seminar and a section of the student conference. Master students take active part in all these activities.

The importance of Master studies is also confirmed by the involvement of students and academic staff of the study program in contracted work in the industry and competence center projects, for example”

- Practical research program project with Ltd ZZ dats, “IWiRoM: Development of a new type of intelligent winter road maintenance support information system and a tailored ERP integration solution to increase the efficiency of maintenance processes”, 2021-2022;
- Practical research program project with JSC TET, “Development of an integrated monitoring and forecasting maintenance solution adapted for dynamic IT infrastructure (DIPIM)”, 2021.
- ITKC program project with Ltd ZZ dats, “Development of a design framework set by analytics data for e-government”, 2019-2020.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The methods used in the study program contribute to the achievement of the aims and learning outcomes of the study courses and the program, the principles of student-centered teaching and learning are taken into account. The organization of the study program is based on RTU strategic aims and tasks:

- In the area of scientific excellence, students are involved in research work and participate in a student conference and other scientific events;
- Industry representatives are widely involved in the training of students in the field of academic excellence in order to train the specialists competitive in the international labor market;
- In the field of organizational excellence, representatives of the student self-government are involved in the organization of the study program and representatives of various organizational units cooperate in the implementation of the study program; students are provided with independent working stations and access to modern software and IT infrastructure

The basic principles for ensuring the internal quality of the study program are:

- The responsible instructor, whose activities are controlled by the responsible unit, is responsible for the implementation of the study course;
- The planning and management of the study program is carried out by the head of the study program;
- Methodological activities are realized via methodological seminars at the organizational unit;
- Overall, the learning outcomes are evaluated and changes in the study program are initiated by the council of FCSIT Institute of Information Technologies;
- The head of the study program controls the use of the e-learning environment.

RTU internal quality management system functions according to the Excellence Approach approved by RTU Senate on 30 January, 2017 (minutes No. 606; see: https://www.rtu.lv/lv/universitate/strategija/rtu-izcilibas-pieeja (Only in Latvian)), as well as to RTU Quality Policy (minutes No. 612; see: https://www.rtu.lv/lv/universitate/dokumenti/kvalitates-politika (Only in Latvian)) approved on 25 September, 2017.

The Quality Policy is aimed at completion of RTU mission and strategic goals – achievement of research, academic, infrastructure, and organizational excellence and recognition. The Quality Policy forms the framework for implementation of RTU Strategy, paving the way for development and improvement of research, studies and organization. The university Quality Policy is in agreement with the standards and guidelines of ENQA (European Association for Quality Assurance in Higher Education). RTU Excellence Approach and Quality Policy are mutually integrated documents, which stipulate that RTU uses EFQM (European Foundation for Quality Management) as a quality model.

The didactic concept of the study program is based on a pragmatic practical model that focuses on the practical result and the competencies of students developed implementing certain tasks (in accordance with the requirements of the professional standard “Information Technology Project Manager”. The concept implies the use of the latest and most advanced teaching methods. It provides for the development of study curriculum and study organization, which ensures sequential and in-depth acquisition of knowledge provided for within the study program and is oriented towards solving real practical tasks and problems, in-depth research of theoretical and practical issues pertaining to the field of information technology project management.

The study program is implemented as full-time studies in Latvian, meeting in parallel the requirements of regulatory enactments, basic education organization principles of RTU and fulfilling all requirements of the study courses. Descriptions of the study courses of the program specify the corresponding body of knowledge, skills and competences, and their evaluation system, define learning outcomes to receive credit points. The assessment procedure for students' knowledge, skills and competences is specified in the decision of RTU Senate of 27 May, 2017 "On the Regulation on the Assessment of Learning Outcomes" that is in compliance with the basic principles and procedure of education assessment defined by Cabinet regulations in the relevant education cycle. Summative assessment is used in the assessment of learning outcomes, when the final grade consists of several components. Full-time studies imply acquisition of 40 CP per academic year and the workload of 40 hours of studying per study week, which makes 1 CP. Within the Master studies, 40% of the workload is taken by contact hours and 60% is individual work (self-education).

The pedagogical models, methods, as well as assessment methods for the implementation of the study courses are chosen by the instructors responsible for the study course, according to the content of the course and the specifics of the study program, as well as student needs. In the implementation of the program, such modern study methods as group work, case and problem studies, seminars, discussions are used. The study courses integrate gamification elements. The study methods used in the implementation of the study program are summarized in the table below.

No	Method / model	Description of a method / model
1.	Lectures	The educator presents the theoretical issues to the students, supplementing the presentation with practical examples, visual material, statistical data. During the lectures, the academic staff use technical means: multimedia projector, computers, whiteboard and other aids. In several study courses, lectures are aimed to promote students' creative participation in the knowledge acquisition process, for example, within the study course DOP728 Information Security and Personal Data Protection, students choose a relevant topic of interest to themselves and present it to other students. Some of the lecture materials are available in the digital form, for example, in 2021, the study courses DOP731 Information Technology Project Management and DOP728 Information Security and Personal Data Protection were digitized. The digitalized study courses include video materials, interactive elements (e.g., digital whiteboards for creating practical tasks), as well as digital knowledge assessment tests.
2.	Project-based learning	Project-based learning is a learning method in which students acquire knowledge and skills by working for a longer period of time to explore a topical and complex issue, problem, or challenge and find the most suitable solution. The study program consists of several study projects where the learning method has been applied - DOP 732 Information Technology Project Planning (Study Project), DOP 730 Enterprise Change Program (Study Project), and "DOP735 Data Governance Study Project.

No	Method / model	Description of a method / model
3.	Experimental or empiric learning	The model of experimental or empirical learning is based on the idea that learning is a process in which knowledge is created by transforming experience. The model contains four stages designed for cyclical repetition and expansion of knowledge. By actively experimenting, students acquire specific experience about the subject under study. By reflectively observing the results of experience from different perspectives, students engage in abstract conceptualization, through which they form theories. Within the study program, experimental learning is implemented in study courses DOP733 Internship and DOP713 Project Management Practice (see descriptions in Section 3.2.4.). The elements of the model are also integrated into other study courses, where practical problems are explored, for example, DOP 732 Information Technology Project Planning (Study Project), as well as involving students in the implementation of research projects (see description in Section 3.2.2).).
4.	Gamification	Gamification implies the use of elements typical of the game in the learning process. Game-based learning elements are integrated into several study courses, for example, the study course DOP731 Information Technology Project Management integrates several games into an interactive environment for learning various useful methods, for example, the “Scrum” principle educational game, the “SAFe” team planning educational game.
5.	Flipped class	Reverse class is a methodology in which students learn material that would normally be given to them during lectures at home, and during lectures, they can deepen their understanding with the help of a teacher. For example, within the study course DOP728 Information Security and Personal Data Protection, the topic of personal data protection is presented in the digital form (video on YouTube platform, independently acquired study materials in ppt mode), which students can learn at their preferred pace. During the lectures, practical tasks on the given theme are solved in order to better acquire practical skills, for example, a register of personal data processing is developed, an assessment of the impact on data protection is also carried out.

No	Method / model	Description of a method / model
6.	Practical and laboratory works	Practical work comprises exercises in solving practical tasks. Laboratory work typically takes place in a computer audience. Students perform practical work individually or in groups (see descriptions in the respective sections). Results and knowledge are evaluated in different ways - in the form of discussions, or by evaluating a particular task according to the criteria known to students in advance. For example, in the study course DOP723 Digital Transformation, laboratory works are created in the form of small-scale research, for the implementation of which knowledge gained within other study courses is used, e.g., analysis of results in statistics. The independent work of the study course is also carried out in the form of a scientific study, the result of which is a draft scientific publication, which can be expanded during the development of the Master's Thesis.
6.1.	Individual work	Independently performed tasks, theoretical literature studies and development of research on the topics related to the study field, presentation of a papers. Individual works help acquire theory in depth and strengthen the skills to perform practical tasks. For example, within the study course DOP 500 System Analysis and Design, students independently perform company modeling using the EKD method.
6.2.	Group work	Group work promotes students' skills to cooperate and work in a group, develops their skills in organizing and implementing collective work, strengthens students' ability to argue and justify individual opinion in a collective decision. According to the requirements of the professional standard "Information Technology Project Manager", teamwork is one of the critical competencies of the profession, therefore, within the study program, group work is a frequently used teaching method. The method is used within the study courses DOP731 Information Technology Project Management, DOP728 Information Security and Personal Data Protection. DOP 732 Information Technology Project Planning (Study Project), DOP 730 Enterprise Change Programme (Study Project), etc. Students in small groups perform various practical tasks in demonstration enterprises, perform case studies or study certain problems. In group work, simulations of certain tasks are typically carried out in conditions close to the real environment. For example, the study course DOP 730 Enterprise Change Programme (Study Project) simulates the full planning cycle of the company's changes. Analysis of the current situation of the model company, modeling of the existing and future architecture of the company, setting of development goals and scenarios, their evaluation, and preparation of a change management plan are implemented.

The program operates the Moodle-based RTU interactive e-learning environment on the web portal www.ortus.rtu.lv, which is regularly used by the study program students, academic staff and visiting lecturers. On the portal, students have access to all relevant information throughout their studies. It hosts relevant study courses (abstracts, requirements to successful acquisition of the study course, lecture syllabi, lecture notes and practical exercise, mandatory literature and other information materials), information on a student's achievements and acquired study courses, the latest news, library information, access to learning and scientific literature and databases, e-mail, etc. The academic staff place different tests and tasks in the e-learning environment for self-control of knowledge, also, the system gives an opportunity to build various interim and module tests. The framework of the portal allows communication with all the academic staff members, but in the framework of current courses - also with the fellow students. The portal hosts discussion forums, regular surveys on the curriculum, quality of the study courses and academic staff that will deliver a study course, presentations, also other audio/video and technical aids.

The most important aspects of the student-centered approach are described below.

1. Involvement of students in the study process and updating of the curriculum

According to RTU procedures, students can regularly give feedback about the curriculum. Students at the program are regularly involved in assessment of the study program quality and take part in decision-making bodies and advisory bodies (the Faculty Council, the Methodological Committee, the Study Field Committee). In addition to formal processes, students regularly meet with the Program Director, when the content and quality of studies is discussed. Mid-term and semestral surveys are organized to let students give feedback about the study courses. Furthermore, at any time students can apply to the Program Director or RTU Study Department with an option to complain anonymously, in order to let them know about problems arising during the studies. Graduates of the study program fill in the form about the studies in general.

2. Learning outcomes

At the study courses, the academic staff clearly define the learning outcomes to be acquired, as well as connect the results with the study program outcomes and credit points of the course. The academic staff take into account diversity of students, offering tasks of different complexity, as well as offering learning materials for the acquisition of both the basics of a study course and the in-depth knowledge of the curriculum of a study course. Students also are offered a vast variety of educational materials (documents, presentations, video recordings, interactive educational materials, etc.).

3. Mobility

RTU offers a wide variety of opportunities to participate in international mobility: 1) Erasmus+ program; 2) Nordtek and Baltech programs; 3) specialized cooperation programs and 4) financing of projects. In the framework of exchange programs, RTU provides students with an opportunity to study voluntarily at some foreign university for some period of their studies (normally, one academic term, but other mobility duration options also are possible), gaining a foreign IT education experience. Furthermore, RTU regularly takes up opportunities of attracting visiting researchers, who share their experience with students through individual guest lectures or the whole study course. Also, when meeting visiting professors at specially organized workshops, the academic staff involved in the program can adopt good practices, which visiting professors share. Mobility opportunities also are the means for advancement of academic staff qualification, wherein they gain experience at foreign universities. More detailed information about the attracted guest professors and mobility of the academic staff is given in Part 3.4.1. "Compliance of the qualification of the involved academic staff".

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs. Students take up employment early. Online attendance opportunities help students reconcile studies and work.

5. Teaching and learning methods

Within the program, various teaching and learning methods mentioned above are implemented, they are adapted by the academic staff to each particular situation (see the description at the beginning of the section). Students can attend individual consultations, including communication in the e-environment using RTU licenses on Zoom and MS Teams platforms, as well as Moodle instant message services.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Embarkment. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classes. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools). In the process of program implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.).

7. Development of the academic staff competences

The academic staff involved in the implementation of the program is provided with opportunities to improve their methodological and didactic skills on a regular basis. The process of academic staff competence development includes methodological seminars organized by the Institute of Business Computer Systems and FCSIT on the application of teaching and learning methods, including innovative machine learning methods, as well as RTU methodological conference.

8. Extracurricular student activities

Students at the program are offered a vast variety of extracurricular activities:

- the management of the program and the faculty actively support student self-government activities and encourages students to take part in them, thus letting them increase their autonomy, giving students an opportunity to implement their ideas, as well as the opportunities of supplementary studies outside lectures.
- Every student of the program is offered opportunities to take part in extracurricular activities (sport teams, dance groups, choirs, etc.).
- Students are also engaged in scientific and research work on the relevant issues in the field, taking part in both local and international projects, resulting in their chances to participate in international conferences.

The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Internship makes an integral part of the study program. The purpose of the internship is to improve the professional skills and competencies of the student in a professional environment, as well as to strengthen and supplement their knowledge in accordance with the requirements included in the professional standard for the IT project manager. The internship ensures the application of theoretical knowledge in solving practical IT tasks: in the development, implementation, and maintenance of IT projects, and helps acquire the skills of the project manager while working in the project team.

The study program includes internships amounting to 6 CP and 26 CP in accordance with the Regulations of the Cabinet of Ministers. Internship in the volume of 26 CP is envisioned for those students whose previous education is 1) a Bachelor's degree in computer management and computer science or compatible education or 2) a Bachelor's degree in other fields of science if the student has acquired the study courses in the field of natural sciences and information technology in the amount of at least 20 CP either within the study program and/or as a listener. The amount of internship of 6 CP is envisioned for the students with 1) a professional Bachelor's degree in information technology, computer systems, electronic commerce, electronic business or 2) a Bachelor's degree in computer science obtained in four-year studies or an education compatible thereto. The internship is implemented in the last academic year, when all theoretical study courses have been acquired and students can apply the acquired knowledge in practice.

26 CP internship is implemented in two parts/stages – 20 CP is intended for the basic practice (study course DOP733 Internship) and 6CP project management practice (study course DOP713 Project Management Practice). During the practical placement, students acquire IT management skills in accordance with the requirements of the professional standard. During the basic internship, students engage in the implementation of IT projects, learning the methods and techniques of project implementation. During the project management internship, students focus on the identification of new project implementation opportunities and take a leading role in planning and implementing new initiatives in the company. The layout of the internship can be viewed Annex P31.

The internship is implemented in accordance with the procedure of organization of internship approved by the RTU Senate on 28 January 2019 (Minutes No. 626). The internship is implemented in accordance with a tripartite internship agreement, which is concluded between RTU, the employer and the student on the provision of the internship place. The internship agreement shall include the purpose of the traineeship, the tasks, the planning of the course of the traineeship, the procedures for the evaluation of the achievements of the traineeship, as well as the duties and responsibilities of the parties. In determining the aims and tasks of the internship, the internship also implies that the students are acquainted with the management structure and principles of operation of the relevant internship organization. Representatives of organizations or enterprises with which a contract on the implementation of the internship has been entered into shall participate in the determination of the aims and tasks of the internship, as well as in the evaluation of the internship. Internship committees have been set up for evaluation of internship reports.

The specific aspects of the internship within the study program are formulated in the 2016 RTU FCSIT Institute of Information Technology Internship Regulations for the Master's Professional Study Program “Information Technology” (Occupational Standard: IT Project Manager). The regulation defines the objectives of the internship, which are aligned with the requirements of the professional standard, describes tasks, organization of internship, report presentation, and documentation. The regulation is designed to define the specific objectives of the internship and to ensure the integration of the standard requirements of the profession into practice. The regulation stipulates that the trainee must participate in the implementation of an IT project or sub-project (in the case of a large project) during its life cycle, performing specific tasks in one of the main phases of the project. During the internship, the trainee must acquire the practical skills necessary to fulfill the qualification requirements of the profession of Information Technology Project Manager, including 1) development of the concept of the IT solution and the description of the project coverage; 2) justification of the choice of the project process; 3) development of the project plan; 4) project quality management; 4) project personnel management; 5) ensuring communication within the project; 6) control of the progress of the project; 6) project risk management.

Once a year, RTU Career Centre organizes RTU Career Day, during which students also have the opportunity to meet company representatives and communicate about future career opportunities. An additional resource that has been developed since 2015 is a website where companies are invited to post vacancies that are topical for RTU students (https://ekarjera.rtu.lv/). Students can connect with the university username and follow the internships and later job opportunities that are topical in their field. Additional support for the advancement of practical skills is RTU Development Fund (https://www.rtu.lv/lv/attistibasfonds). During the year, several hundred competitions for the advancement of practical skills are offered, which are organized in cooperation with companies and where students could acquire practical skills.

A meeting with students is organized at the end of the first year studies. The internship related topics are discussed during the meeting and a survey is conducted to identify internship placement needs. If students indicate a need for help, a joint review of CV is organized, RTU Career Center is involved and companies providing suitable internship opportunities are recommended.

Students implement internships primarily in IT development companies, as well as in IT departments of companies in other industries (which use complex IT solutions). In 2020 - 2022, the following companies offered internship opportunities to the students: *Accenture, Printful, Visma, Emergn, ScandiWeb, LMT, TeT, TestDevLab, WeAreDots*, as well as other companies in the industry. During internship, students implement IT project management or IT management tasks in accordance with individually defined aims and tasks. In the internship reports, students point out how the courses acquired within the study program have helped them to start working in the field, highlighting such study courses as “Information Technology Project Management”, “Information Technology Project Planning (Study Project)”, “Object-Oriented System Analysis” and “IT Project Management Tools”. In the internship reports, students also give recommendations for improvement of the study program, which are reviewed and taken into account for continuous improvement of the program.

The assessment questionnaires and feedback provided by employers and internship supervisors show that students understand and are able to practically apply the knowledge and skills acquired during the study process, are able to identify problems related to the theme of internship in the company, choose the most appropriate problem-solving methods for prevention of the company's problems and improvement of its processes. Evaluations of internships are mostly positive – from 7 (good) up to 10 (excellent). Employers and internship supervisors in enterprises have confirmed that the knowledge, practical competencies, and skills acquired by the students meet the requirements of professional activity specified in the professional standard.

More than 80% of students after internship continue their professional activities in the internship company. Some students demonstrate professional development and career development during the internship (transition to positions, etc.).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Regarding the Master Thesis themes, each student has the opportunity to choose the research field and theme of their graduation paper according to their interests, in consultation with the academic staff. Within the study program, the graduation papers are mostly developed on the topics covered within the study program, studying problems encountered by the students during their internships in the industry or observed in their previous professional activities.

The themes of the graduation papers are selected with regard to the current events in the information technology sector in Latvia and the world:

- Increasing the efficiency of products and service delivery processes – creation of delivery methods and adaptation to the achievement of company's goals (current trends of recent years - DevOps, SRE, Scaled agile methods);
- Data analytics and management – extensive data sharing and analysis in the implementation of daily processes (including monitoring and correcting the quality of process execution in real time or near-real time).
- Business process analysis and automation – process identification and rationalization, execution of business processes with minimal human involvement (including resource management for capacity and capacity building purposes and use of human resources for high value-added activities).
- Use of innovative technologies in processes, products, services – traditional activities and products are complemented by digital technologies, e.g., wearable devices. Digital service ecosystems;
- Information security – protecting the data and digital identity of the company and individuals.
- Development of software engineering technologies – research and application of the latest software engineering technologies for resource optimization in the software development lifecycle, including requirements engineering, programming, software testing, deployment, etc.

The topics of the works change according to the latest developments in the industry, which can be observed both in the range of the technologies considered and methods (IT project management, IT management methods, etc.). For example, in 2010 more research was carried out on the use of "waterfall", iterative and capable methods, in 2020, 2021 the latest trends were examined - bulk capabilities methods (SAFe, etc.), DevOps approach, etc.

The most important topics studied in the works are:

Use of Agile methods in software development processes and projects – the use of various frameworks (Scrum, SAFe, etc.) to increase the efficiency of processes and projects is explored in the final works. The works cover specific sectors (e.g., trade, finance and insurance) and different types of projects (e.g., shared information technology projects, maintenance projects, etc.).

Examples of Master Theses themes (2015-2021):

- *Towards Improved Understanding of Scrum Framework at Software Development Companies;*
- *Using Scrum Framework for Productivity Increase in Development Team;*
- *Controlling Technical Debt Within Enterprise IT Projects Using SAFe Framework;*
- *Applying Scaled Agile to Agile Delivery Project;*
- *Managing and Improving Performance of Large-scale Agile Projects.*

Use of innovative technologies to solve problems important to business and society – the graduation papers explore the current problems and the use of technologies to solve them. The papers analyze problems, study related business processes, data and technologies, as well as develop recommendations for solving problems. The most frequently viewed innovative technologies in Master Theses in recent years are artificial intelligence, automation of robotization processes (RPA), cloud computing, internet of things (IoT), virtual and augmented reality.

Examples of Master Theses themes (2015-2021):

- *Building a Mobile Augmented Reality Using Cloud, Fog and Edge Computing;*
- *Improving Effectiveness of Disaster Recovery and Business Continuity Plan Using Cloud Computing;*
- *Using Machine Learning to Analyze and Forecast Student Dropout;*
- *Business Process Compliance Evaluation for Robotic Process Automation;*
- *Analysis of Potential of Reinforcement Learning Trained Conversation Agents in Customer Service.*

Use of software development technologies and frameworks – graduation papers analyze current technologies and frameworks, compare them, evaluate the benefits of use, as well as implement practical application in solving certain problems or realizing new opportunities (including creation of new products and services). The works cover both open-source technologies and commercial technologies (e.g., SAP).

Examples of Master Theses themes (2016-2021):

- *Usage of Fourth-generation Programming Languages in Business Application Development;*
- *Analysis of Progressive Web Application Technology for E-commerce Solutions;*
- *Analysis and Evaluation of Database Semantic Technologies.*

Cybersecurity and information protection – the graduation papers explore the current threats to the persistence of the activities of companies and information security, typical vulnerabilities and offer methods and solutions to mitigate the related risks. For example, the protection of wireless networks, cloud solutions, etc. is considered, etc. The provision of cybersecurity to specific sectors of companies (e.g., public administration) has also been explored.

Examples of Master Theses themes (2015-2021):

- *Recommendations for the Elimination of Wireless Network Security and Safety Risks;*
- *Security Techniques for Protecting Data in Cloud Computing;*
- *Cybersecurity Solution Development for Government Institutions;*
- *Security Aspects of Internet of Things.*

Improvement of the operation of enterprise applications and business analytics solutions – graduation papers explore current problems and opportunities for improvement in enterprise applications (for example, enterprise resource management systems) and business analytics solutions and develop proposals to improve their performance in specific areas (e.g., adaptation, performance, usability).

Examples of Master Theses themes (2015-2021):

- *Improving Performance of Business Warehouse Reporting in SAP ERP Using In-memory Computing;*
- *The Use of Cloud Solutions in Scaling CMS Processes;*
- *Improvement of Web Services Based Integration Solutions in Enterprise Applications.*

IT governance – graduation papers analyze IT governance and IT service delivery processes (release management, incident management, problem management, configuration management, change management, change management, etc.), identify their shortcomings and develop recommendations for efficient process implementation in companies. The processes have been analyzed taking into account the latest developments in the industry, such as the introduction of DevOps and site topicality engineering (SRE) approaches in companies. The works often analyze best practice recommendations (e.g., ITIL) and offer their adaptation to address specific cases.

Examples of Master Theses themes (2015-2021):

- *Incident and Problem Issue Classification and Workflow Automatization;*
- *ITIL Self Assessment Approach for Small and Medium Digital Agencies;*
- *Change Management Implementation in Organization: Formal or Agile Approach;*
- *Change and Release Management Processes in Social Games Development.*

Comparison, selection and adaptation of IT project management methodologies and tools – in the graduation papers, the application of existing IT project management methodologies for specific cases (enterprise sector and other specific indicators, project types, etc.) are studied, their comparison is carried out and recommendations for the application of methodologies are developed. Among other things, the papers examine in depth aspects of quality, as well as risk assurance and management. The papers also cover various current project management tools and their application.

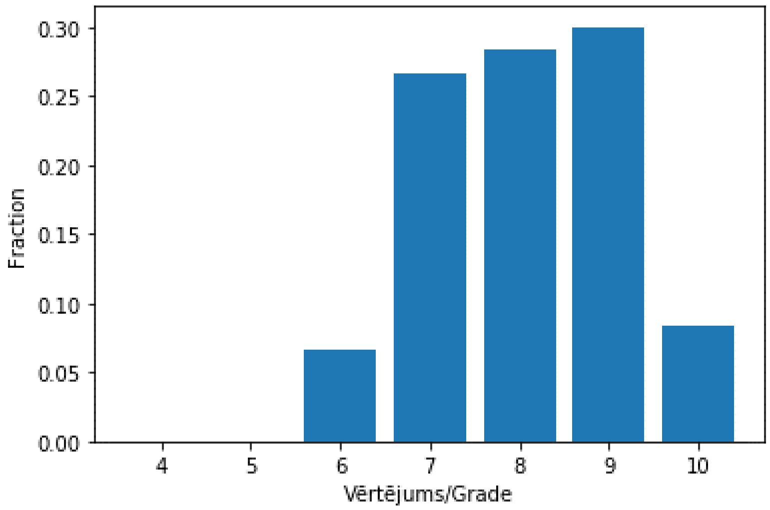
Examples of Master Theses themes (2015-2021):

- *IT Project Lifecycle Model Selection in Government Institution;*
- *Optimal Control Strategy Analysis of IT System Implementation Projects;*
- *Change of Project Management Information System in Software Development Company;*
- *Implementation and Impact Evaluation of Project Management Tool.*

Typically, in the graduation papers, problem analysis, solution design, prototyping, and evaluation of solutions are carried out, as well as recommendations are developed for solving the identified problems. The results of the graduation papers are often used to implement improvements at the place of work or internship of students. Analyzing the evaluation of the papers given by reviewers (experts in the field), it can be concluded that the topics of the papers are important and topical in industrial practice, the results of graduation papers also can be used in practical applications.

The average grade for the graduation papers is 8, and most often the evaluation is 9 (29% of the cases). The relatively high grades may be explained by the fact that lower quality works are not completed or are not allowed to viva voce examination. Unfortunately, students who have failed to develop a graduation paper at the first iteration rarely try to improve their work. Normally at the study program students do not change the topic of their graduation papers. The average performance of students is constant during the reporting period.

The figure shows a fraction of all 136 Master thesis defended in the reporting period (2013-2021) reveiving the specific grade.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- FCSIT Institute of Information Technology;
- FCSIT Institute of Appllied Computer Systems;
- FCSIT Institute of Intelligent Computer Technologies;
- RTU Faculty of E-learning Technologies and Humanities;
- RTU Faculty of Engineering Economics and Management.

RTU institutes and their departments ensure the training and methodological work: develop and update the curriculum, provide delivery of corresponding study courses, supervision and examination of PhD theses and carry out other activities related to teaching, methodological and research work. Elective study courses are offered also by other organizational units of RTU and other higher educational establishments. The study program is granted with assistance of the general RTU support staff, which provides the functioning of the infrastructure.

Riga Technical University provides the study program with a corresponding learning environment. It comprises lecture halls and classrooms, laboratory equipment, e-learning environment and bibliographic resources. Each study course is provided with a necessary learning environment.

The studies take place at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at 10 Zundas Embarkment, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The faculty is located in the same campus as RTU Scientific Library, which provides rooms for group work and quiet reading rooms. The conference center offers a large lecture hall with 560 seats, the faculty has 12 lecture halls with 25-200 seats and 10 computer classes with 20-30 workstations. Students can use their laptops and connect to RTU Wi-Fi networks. The lecture halls are equipped with modern audio and video equipment, including a digital projector, a computer, a remote control, audio devices, microphones and cameras.

Modern software that corresponds to educational needs and the current trends is used in the study process:

- FCSIT cloud computing platform "CloudStack", created within the ERDF project "(IKSA-CENTRS) Establishment of national research center of information, communication and signal-processing technologies". Students can also connect to "Microsoft Azure" cloud computing environment;
- Agreements on the free use of software in research are signed, e.g., the agreements with MatLab, CPLEX, Microsoft, SAP, JetBrains, JIRA. In case of necessity, supplementary software and computing resources can be purchased on the funds of organizational units;
- Open-source software, including Linux, Docker, Kubernetes, Python, R and others, depending on the specifics of the study courses, are widely used. Students can use the local server of Jupyter https://jupyter.vitk.lv/ and public resources for data analysis purposes.
- During the studies, usage of shared resources is promoted, including "GitHub", "Miro" and "SharePoint".

For additional convenience of RTU students, academic staff and employees, RTU leases "Microsoft Windows" and "Microsoft Office" software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail service.

The server technologies are also used within study courses. Students are provided with remote access to specialized software using "Windows terminal services" including "Visual Studio", "Enterprise Architect", "SqlServer", "Eclipse", "PhpStorm", "MATLAB R2015b", "Microsoft Dynamics AX". More complex tasks are solved using a computer cloud, which consists of 14 servers each having 128GB RAM (DDR4@2400MHz), 2 pcs., CPU (Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz, 8 Core), disk array capacity 120TB and specialized servers. For example, DOP391 Information Systems Management uses two Supermicro servers, which consists of one 8-core processor Intel(R) Xeon(R) CPU E3-1275 v6 @ 3.80GHz, 64GB RAM memory, 1TB SSD disk space and 4TB SATA hard disk size. The second server consists of one 16-core processor Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz, 128 GB operation memory, 2TB SSD disk space and 8TB SATA hard disk size, to let students arrange their isolated work environment computer network security, solutions for design and testing of IT system supervision and management. Both servers have Proxmox VE hypervisor installed and students use “nested virtualization” technology.

In order to provide simple and effective identification of IT users, the IT user identity management system has been introduced, and as a result, each IT user has a unique electronic identity created and maintained, and made valid in all information systems. In addition to the mentioned above, a user session management system in IT systems is provided, where at one single application in RTU information systems, IT users do not need a repeated authorization. This offers the user experience of a joint integrated information system, which remembers various identification data and inputs it again to implement different scenarios of IT application.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalogue of all IT services in the same place.

For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programs (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programs, the study course register (https://info.rtu.lv/rtupub/disc2/list - public part), development of individual study plans, drafting of orders, study courses and training, input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in administration of the study process.

In order to ensure efficient study process, “Moodle” e-learning environment is used, where all binding information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-instructor communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc. On ORTUS portal students can see their financial information, make requests for documents (certificates, academic records, copies of the agreement, etc.). Academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

More than 130,000 unique study course websites have been generated in the RTU e-learning environment since 2007. Students can connect and get access to electronic learning aids at any time and place.

Effective classroom resource management and planning of studies is provided by digitalization of classrooms and time schedules (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or member of the academic staff can see their schedule, specifying places, times, names of lecturers, classroom names and types of classes. To provide users with extra comfort, the system significantly facilitates planning and scheduling of classes, as well as optimizes classroom occupancy and use efficiency.

The Scientific Library of RTU is an academic library of state significance, which has obtained its status as a result of library accreditation. The Scientific Library of RTU provides the necessary information for RTU study process and research activities, performs library, bibliographic and information services for RTU students, teaching staff, and employees. The Library’s collection includes 1.3 million printed documents and e-resources in the databases relevant to RTU fields.

In 2016, significant investment was made in the development of the library infrastructure, with the construction of an additional 2240 m2 of space for the Central Library. The total area of the library premises is 6393 m2, of which 3417 m2 are for reader services. There are 713 workstations for library users. The library has four group rooms and six individual cubicles, a rare edition reading room and a conference room. The library is accessible to users with reduced mobility.

In order to improve the SL activities and to meet the information needs of academic and research staff, the Library Council has been established, which decides on replenishing the library collection with printed publications and subscribing to the necessary databases. The Library Council has approved the Compilation Policy of RTU SL Collection, which sets the basic principles of the collection development in accordance with the areas of RTU academic and research activities. When RTU provides funding for the Library, the funding for information resources for each study program is calculated. The collection is replenished according to the recommendations of the heads of study program, researchers, in compliance with the allocated funding. By contacting the SL Collection Development Department regarding replenishment of collection, the desired editions can be ordered at the Library website by filling out an order form (https://www.rtu.lv/lv/studijas/biblioteka/pakalpojumi-3 (Only in Latvian)), an application form, contacting by phone 67089353, or visiting the Library at 5-105 Paula Valdena Street. The SL offers a guide, which includes websites of various Latvian and foreign publishing houses and bookstores for searching publications and e-resources.

Database subscription agreements are concluded both directly with the supplier and through the Cultural Information Systems Centre, which is the Latvian national representative for the international non-profit organization Electronic Information for Libraries (EIFL http://www.eifl.net/). The EIFL Licensing Program offers libraries of state importance to subscribe to internationally recognized databases at a significantly reduced subscription fee that is not offered to individual subscribers, thus saving the financial resources of the libraries.

Every month, the list of the newly-received literature is published in the SL newly-received literature bulletin (https://www.rtu.lv/lv/studijas/biblioteka/jaunieguvumi).

The database subscriptions maintained by RTU Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/abonetas-datubazes (Only in Latvian)):

- ProQuest Ebook Central, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, EBSCOhost eBook Academic Collection, Wiley Online Library, SpringerLink, The International Monetary Fund.
- Databases financed by the Ministry of Education and Science available to RTU Scientific Library: ScienceDirect, SCOPUS (Elsevier), Web of Science.
- Latvian databases: LETA, Letonika, the Database of Latvian Standards (available on the premises of the Library).

Database usage at the Scientific Library of RTU has been growing since 2016.

The new library premises have allowed to extend the range of services. Since the opening of the new premises in 2018, the number of visits to the library has increased from 103,825 to 691,200. The Central Library is open to users from Monday to Saturday. (https://www.rtu.lv/lv/studijas/biblioteka/darba-laiki-un-kontakti (Only in Latvian)). There is a 24/7 reading room. During the summer period, the Central Library is open every weekday with reduced opening hours.

The SL information sources are provided in the open access. Books and periodicals relevant for the study fields are located in the main building of the Scientific Library (5 Paula Valdena Street) in compliance with UDC indexes. The last copy of the oldest editions that comply with RTU profile is stored in the library repository. They are always available to users.

The on-duty librarian helps find the necessary resources. More detailed information and consultations are provided by bibliographers. The SL has librarians responsible for particular fields of science (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija (Only in Latvian)).

Searching for library resources is ensured by the Primo Discovery search tool (https://www.rtu.lv/lv/studijas/biblioteka/vienota-informacijas-meklesana (Only in Latvian)). It allows searching for the information in the library catalog (RTU SL Catalog (UK) - Basic Search (kopkatalogs.lv), subscribed databases, as well as in databases created by the Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/bibliotekas-veidotas-datubazes (Only in Latvian)). Searching for the information in the joint electronic catalog (Kopkatalogs - Basic Search), one can simultaneously obtain information about the available resources in 12 libraries in Latvia. Both the electronic catalog and RTU portal ORTUS can be used to reserve the library resources remotely. Remote access to databases is also provided. Since the introduction of RFID technology, users have been able to use five book-dispensing self-service vending machines and return books to a book-sorting vending machine around the clock. Book usage term can be prolonged remotely.

The SL provides students, academic staff and other stakeholders with different types of individual consultations and group training in information literacy (https://www.rtu.lv/en/studies/biblioteka/lietotaju-apmacibas (Only in Latvian)).

Editions that are not available in the Scientific Library are delivered through an interlibrary subscription or international subscription. Internet access is provided throughout the Library. The SL provides copying, scanning, printing and binding services, there is also a self-service canteen.

The SL can be contacted via: Ask the Librarian (https://www.rtu.lv/lv/studijas/biblioteka/jauta-bibliotekaram (Only in Latvian)), using information e-mail, calling to the information phone number (https://www.rtu.lv/lv/studijas/biblioteka/darba-laiki-un-kontakti (Only in Latvian)).

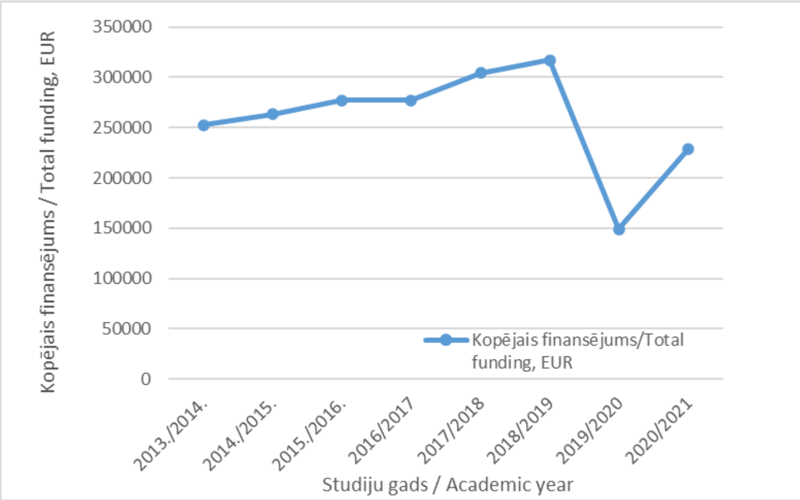
The academic staff are advised to recommend students at least one e-book from the available bibliographic resources.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The study program is financed from the regular budget of the Ministry of Education and Science of the Republic of Latvia and the tuition fees. 100% financing on the study program “Information Technologies” comes from the regular budget of the Ministry of Education and Science, because Information Technologies is a priority program according to employers’ recommendations, which is assigned appropriate state budget funding. Distribution of the funding is set out in RTU regulations “On Approval of the Methodology of Distribution and Allocation of Funds to Organizational Units of RTU in Academic Year 2021/2022”. They specify the allocation of funds for centralized RTU services and organizational units that provide the study courses. The full annual tuition fee is set at EUR 6112.92.

The available funding for the study program is illustrated in the chart. During the reporting period, the study program funding has slightly decreased along with the decrease in the number of students. The fluctuations observed in recent years of study are related to fluctuations in the number of students and changes in the allocation of funding.



Remuneration (43%) takes the major part of expenses (academic year 2021/2022). Appropriate funding is also allocated to support the infrastructure. Certain funding is planned for purchase of bibliographic resources, although a part of these resources is purchased by RTU (IEEE) or the state (Scopus). Travel expenses make 0%, because of COVID-19 pandemic restrictions on travelling. The cost of retrofitting equipment this year is low, as the equipment was renovated before moving to the new premises.

Cost item	**Sum**	%
Average actual costs per 1 student, EUR	3637.57	100%
Remuneration	1580.33	43%
Employer's SSIC, compensations and benefits	375.10	10%
Business trip expenses	5.32	0%
Payments for services	109.41	3%

Cost item	Sum	%
Materials, energy resources, inventory	22.17	1%
Purchase of books and magazines	147.35	4%
Purchase and modernization of equipment	57.00	2%
Administration costs *	477.50	13%
Infrastructure costs *	667.86	18%
Social security costs	195.53	5%

The minimal number of students in the study program that ensures its cost-effectiveness is 28 students (total in all variants).

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualification of the academic staff involved in the implementation of the study program fully complies with the conditions for the implementation of the study program and the requirements of regulatory enactments, which ensures achievement of the aims of the study program and the corresponding study courses and learning outcomes (see CV of the academic staff). RTU's elected academic staff, guest lecturers and leading specialists in the field are involved in the implementation of the study program. The curriculum and design of the study courses is the responsibility of RTU elected academic staff. Usually, under the guidance of the head of the department and the responsible instructor, a team of academic staff works on the implementation of the study course, where professionals, PhD students, guest lecturers can be attracted. In the Master's study program, all the academic staff responsible for the study courses hold a PhD in the corresponding field. RTU elected academic staff and guest lecturers from the industry with a Master's degree and at least 7 years of experience in the IT field also participate in the implementation of the program.

Compulsory and compulsory elective study courses of the study program are conducted by the faculty from the Faculty of Computer Science and Information Technology of RTU with a qualification corresponding to the requirements and high competence in the relevant field. Two professors elected to RTU academic positions (Prof. Jānis Grabis, Prof. Oksana Ņikiforova), five associate professors (Assoc. Prof. Jānis Kampars, Assoc. Prof. Andrejs Romanovs, Assoc. Prof. Jānis Stirna, Assoc. Prof. Jānis Stirna, Assoc. Prof. Arnis Lektaurers and Assoc. Prof. Sergejs Paršutins), five assistant professors (Vineta Minkeviča, Rūta Pirta-Dreimane, Vladislavs Minkevičs, Solvita Bērziša, Jānis Eiduks) and one lecturer (Lauma Jokste) participate in the implementation of the compulsory and compulsory elective part of the program. 17 PhD degree holders participate in the implementation of the study program. Short biographies of professors and associate professors involved in delivery of the study program are given below.

Prof. Jānis Grabis – Director of the Institute of Information Technology of RTU Faculty of Computer Science and Information Technology. A co-author of over 125 "Scopus" indexed international scientific publications about the issues related to enterprise integration, optimization and digitalization of project management and business processes ("Scopus" h-index is 12). Prof. Grabis worked as a researcher or a visiting professor at the University of Michigan-Dearborn and Stockholm University; has led and participated in more than 12 scientific research projects, including EC framework programs, ERDF practice-oriented research, LCS (Latvian Council of Science) Fundamental and Applied Research Program, projects of EEA and Norway grant and State Research Program, as well as in more than 10 contracted works in cooperation with the companies. Head of the Bachelor, Master and PhD study programs in Information Technology. In 2021 was recognized as RTU Academic Staff of the Year.

Professor Oksana Ņikiforova obtained a doctorate in engineering. She has a long-term academic work experience, delivering lectures and practical classes within the study course "Object Oriented Systems Analysis". In her capacity of a systems analyst and product owner with the experience in the industry, she helps students develop competencies in object-oriented systems analysis both in modern perspective and showing students the historical development of the methods and documentation of systems analysis in different types of projects and software development tasks of different level of abstraction. Her extensive experience in the management of research projects, student-initiated software development projects and industrial product development projects and participation in their implementation ensure her competence to participate in the implementation of the course "Object Oriented Programming Practice (study project)", organized as small software development projects using object-oriented technology as one of the means of project implementation.

Assoc. prof. Jānis Kampars – Member of the Board of the Latvian Open Technology Association, Latvian representative in the group of independent experts of the EC *Destination Earth* initiative. A co-author of more than 30 international scientific publications on cloud computing, horizontally scalable real-time data processing systems, digital transformation indexed in Scopus database (Scopus h-index is 6). Actively cooperates with the Latvian Association of Local and Regional Governments, Riga Planning Region, Riga and Kuldiga Municipalities, the Ministry of Environmental Protection and Regional Development, Latvian State Roads, Latvian Road Maintenance Authority and Latvian companies in the issues of digital transformation, open source and open data promotion, use of digital twins. Assoc. prof. Kampars uses the established cooperation network to enhance the study process. Participated in the implementation of more than 9 research projects.

Assoc. prof. Andrejs Romānovs – Dr.sc.ing., associate professor and leading researcher at RTU Institute of Information Technology, Head of the Department of Modelling and Simulation, Head of RTU Master study programs "Logistics System and Supply Chain Management" and "Cybersecurity Engineering". Over the last 6 years, academic and applied research has been carried out in the following areas: Modelling and design of information systems, logistics and supply chain management, development of cyber-physical systems and cybersecurity. Research has been carried out by participating in the implementation of several international and local scientific projects, including:

- Erasmus+ StrategicPartnerships for higher education KA203-A4715D6E project 2020-1-FI01-KA203-066624 “Cybersecurity Curricula Recommendations for Smart Grids” (2020-2023) project manager;
- European Innovation Partnership Programme 16.1 project “Innovation solutions for planning and organization of agricultural and forestry products transportation” (2019-2022) project manager;
- COST ActionIC1404 Multi-Paradigm Modelling for Cyber-Physical Systems (2014-2018) performer;
- 2020 State Research Program "Covid-19 Mitigation" project "Prospective technologies for resilient and safe services, ARTSS", performer;
- 2014-2017 The project "Applications of Sensor Networks and Signal Processing in the National Economy" (2014 – 2017) of the National Research Program "State Program of Information and Communication Technologies (ICT) Research (NexIT)" of the National Research Program "Next Generation Information and Communication Technology (ICT) Research Program (NexIT)";
- RTU research platforms project competition 2019/2020 for science and innovations within RTU research platforms, co-leader of the project ZI-2020/2 "Development of orthopedic rehabilitation assistance vehicles and research on their cyberphysical models ".

Andrejs Romanovs has published 53 articles in international scientific publications and collections of conference articles (40 of which are indexed in Scopus). Andrejs Romanovs has participated in several academic and professional development events (conferences, seminars, workshops) in the fields of research of interest to him, in total 634 academic hours.

Associate Professor Jānis Stirna holds a PhD in Computer Science, conducts research and participates in the delivery of the study courses for Master's students. Jānis Stirna works as a professor at Stockholm University. Jānis Stirna is the author of 67 conference publications, 14 book chapters, 11 journal publications, he is the editor of 17 collections of articles. His Google Scholar H-index is 24. Jānis Stirna has participated in 13 scientific research projects financed by the European funds, including projects of the EC Framework Program. He co-authored several modelling approaches – ENP, EQF, and 4EM. The abovementioned methods are also taught in the study course “Systems Analysis and Design” of the study program. Research areas: enterprise modeling, information systems analysis and design. Jānis Stirna is a member of several organizations, currently, he is the Vice-Chair of IFIP working group 8.1 Information Systems Design and Evaluation.

Assoc. prof. Arnis Lektauers, Dr.sc.ing. – Associate Professor and Leading Researcher at the Department of Modeling and Simulation of RTU FSCIT Institute of Information Technology. A co-author of more than 45 international scientific publications on high-performance interactive computer simulation solutions for complex systems. Participated in more than 10 scientific research projects, including EC Framework Program, EEA and Norwegian grants, State Research Program projects, as well as implemented more than 5 contracted works in cooperation with the enterprises. Along with academic and scientific experience, he has 26 years of professional experience in local and international IT companies. He has been a member of the Modeling and Simulation Group of the NATO Science and Technology Organization since 2011.

Associate Professor Sergejs Paršutins - Associate Professor at the Department of Modelling and Simulation of RTU Institute of Computer Science and Information Technology, Institute of Information Technology. Co-author of more than 30 international scientific publications indexed in Scopus database in various fields of applications of artificial intelligence and machine learning technologies ("Scopus" h-index is 5). He has participated in more than 21 scientific research projects, including the EC framework program, the ERDF applied research projects, the Fundamental and Applied Research Program of the Latvian Council of Science, HORIZON, and the National Research Program projects. Delivers courses and supervises graduation papers at the Bachelor's, Master's, and PhD study programs in Information Technology.

Assistant Professor Vineta Minkēviča holds a PhD in Mathematics, she conducts scientific research and delivers study courses for Bachelor's and Master's students. Vineta Minkēviča has more than 20 years of experience in the delivery of the study courses, she is the author of many publications and has participated in the implementation of numerous research projects at the national level.

Assistant Professor Rūta Pirta-Dreimane holds a PhD in Engineering, she carries out scientific research, participates in international conferences, as well as conducts study courses for Master's students and students at further education programs. Rūta Pirta-Dreimane has been delivering the study course "Restructuring and Change Management" since 2016, and since 2021 – the course "Information Security and Personal Data Protection" and "Information Technology Project Management".

Rūta Pirta-Dreimane has ~15 years of practical experience in the IT industry, including managing teams, projects, and processes. Rūta Pirta-Dreimane holds a professional certificate of an IT project manager (Prince2) and is constantly improving her knowledge in the fields related to the study program. In recent years, Rūta Pirta-Dreimane has attended several professional development courses, as well as participated in industry conferences and seminars (for example, the international conference "Enterprise Architecture for Financial Institutions" in 2019, while in 2021 – the forum "Global Summit of Company Architecture"). Rūta Pirta-Dreimane uses her practical knowledge in the implementation of the study courses.

Rūta Pirta-Dreimane has participated in the implementation of 5 international and national scientific projects and more than 80 IT industry projects (system implementation, IT strategies, etc.), the project results are also used for in the course of implementation of the study courses. For example, the results of the international project "Advances: Promotion of Public Security Capabilities" on the establishment of cybersecurity study courses have been considered in the improvement of the study course "Information Security and Personal Data Protection".

Rūta Pirta-Dreimane participated in the digitization project of study courses in 2022, as a result of which the study course "Information Security and Personal Data Protection" within the program has been made available in the digital form (video, interactive tasks, online knowledge testing).

Assistant Professor Solvita Bērziša holds a PhD in Engineering, she performs scientific research, participates in international conferences, as well as delivers study courses for Master's students. Solvita Bērziša delivers the study courses "Project Management Tools" and "Data Management Study Project" within the study program. She is a certified project manager (PMP). Solvita Bērziša has participated in the implementation of several research projects, her research areas cover project management information systems, use of artificial intelligence solutions in project management and project data analytics. As a guest lecturer, Solvita Bērziša teaches data visualization methods at RISEBA. Solvita Bērziša has 15 years of experience in the IT industry, and currently she works at Accenture, one of Europe's leading IT companies, as a data scientist and big data consultant. Solvita Bērziša also volunteers in various organizations, she organizes events in the meetup group "Riga Data, Advanced Analytics, AI" and participates as a mentor in "Riga TechGirls" and "Vilnius Women Goes Tech" programs.

Assistant Professor Vladislavs Minkevičs holds a Master's Degree in Engineering, conducts scientific research, participates in international conferences, as well as delivers study courses for

Bachelor's, Master's and continuing education students. Since 2020, Vladislavs Minkevičs has been conducting the study course “Information System Safety”. Vladislavs Minkevičs also conducts the continuing education course “Information Security and Personal Data Protection”, the lessons learned and experience gained within the course are used to develop the content of the study program as well.

Vladislavs Minkevičs has more than 20 years of practical experience in the IT industry as an IT security manager and personal data protection specialist, he holds international information security management certificates (CISA, CISSP). Vladislavs Minkevičs is also a certified personal data protection specialist. Vladislavs Minkevičs is constantly improving his professional knowledge in the fields related to the study program, both by participating in various seminars and interest groups (for example, seminars, and trainings organized by CERT), as well as by working practically in the field and solving current problems.

Vladislavs Minkevičs participates in international and national scientific projects, the results of which are also integrated in the study courses. For example, solutions developed within the project “ARTSS: Prospective technologies for resilient and safe services” can be used to demonstrate technological controls and tools for information protection.

Lecturer Lauma Jokste holds a Master's degree in Engineering, conducts scientific research work, participates in international conferences, as well as delivers the study courses for both Master's and further education students. Lauma Jokste has been conducting the study course “Information Technology Project Planning (Study Project)” since 2017 and the course “Information Technology Project Management” since 2021. Lauma Jokste has developed and conducts a further education course “Design thinking, project, product and process management with Agile, Scrum, Lean, Kanban” (professional development), the lessons learned and experience gained in the course management are used to develop the content of the study program as well.

Lauma Jokste has ~ 10 years of practical experience in the IT industry as a systems analyst and IT project manager. Lauma Jokste has a professional certificate in capacity development project management (SCM). Lauma Jokste constantly improves her professional knowledge in the fields related to the study program, as well as shares her experience with other academic staff, for example, in 2021 Lauma Jokste delivered a presentation at the RTU Academic Conference with a presentation “Improvement of the study process using design thinking, abilities, and interactive tools”.

Lauma Jokste participates in scientific projects, the results of which are also used for improvement of the study courses.

In 2022, Lauma Jokste participated in the project of digitization of the study courses, as a result of which the study course “Information Technology Project Management” has been made available in the digital form (video, interactive tasks, online knowledge testing).

Guest lecturers – IT industry professionals who share their knowledge and professional experience – regularly participate in the study program. For example, in 2020 and 2021, the visiting lecturer, a start-up founder Jānis Kondrāts participated in the study course “Information Technology Project Planning (Study Project)” with a presentation "Attraction of investments and product development. Exonicus experience story”. In 2021, the study course “Information Technology Management” hosted a guest lecture, during which data center and cloud computing technologies, data center industry development trends and areas for 2021-2023, infrastructure of Latvian data centers, private, public, hybrid cloud construction and their application in ensuring business requirements, structure and principles of operation of cloud computing platforms, structure and principles of operation of data centers (virtual tour) were discussed. The guest lecture was led by Arkady Rapoport, TET data center and cloud services product manager, and Māris Sperga, Business Development Director of TET Data Centers. In 2018, the guest lecture on the continuous delivery of the software conducted by the representatives of the company C.T.Co took place. In 2017, IT professional and consultant Ēriks Eglītis presented a guest lecture "Challenges of practical life in the implementation of large-scale IT projects". In 2017, in the study course "IT Project Management" a guest lecture of the representatives of Lts "AA projekts" took place on the topic "Requirements Management during the IT Project". In 2015, the head of Accenture Latvia, Maksims Jegorovs, gave a guest lecture on project management in an international company within the study course "IT Project Management".

The study courses in management, humanities and social sciences are primarily led by academic staff from the Faculty of Engineering Economics and Management of RTU with a qualification corresponding to the requirements and high competence in the relevant field.

Associated Professor, Dr.sc.soc. Gunārs Ozolzīle Professional experience: has been teaching the courses in social sciences (sociology, polytology, project management auditor and Latvian political system) at RTU and other Latvian higher education institutions (UL, Latvian Academy of Sport Education (LASE), the Latvian Police Academy, College of Business Administration and Higher School of Social Technologies) since 1989; the chair of the state examination committee of LLU Faculty of Economics and Social Development in the Bachelor and Master study program "Sociology of Organizations and Public Administrations" (since 2005). Conducted research at the market and social opinion research company Baltijas studiju centrs (1991-2018). Research link with students is ensured by the scientific research work for LCS, the Ministry of Defence, and EU-funded projects, participation in the conferences, and development of scientific publications. Scientific research activities are mainly related to the stability and efficiency of the Latvian political system, as well as the reformation opportunities of certain political institutions. Such research focus enables to enhance the quality of the delivered study courses and to provide the link with political processes in the country. Regular methodological work also promotes teaching efficiency – development of teaching and learning tools, and other methodological tools and materials. G.Ozolzīle's qualification meets the requirements of the study program and regulatory enactments, and ensures achievement of the aims and learning outcomes of the study program and the study course "Business Etiquette".

Professor Nataļja Lāce graduated from the Faculty of Engineering Economics of the Riga Polytechnic Institute (currently Riga Technical University, hereinafter RTU) in 1982, obtained a PhD degree in economics for her PhD Thesis "Economic Provision of the Metal Saving Process in Product Design" (candidate's degree of Doctor of economic sciences, 1990 and Dr.oec., 1993). She has held academic positions at RTU Faculty of Engineering Economics and Management (hereinafter – FEEM) for 30 years. N. Lāce has 12 years of experience as a professor, a 9-year head of the department and a 12-year program director at RTU. She has worked at Bachelor's, Master's and PhD programs. Professor Lāce is the Head of the Department of Finance and Economics of the Company and the Director of the Master's program "Business Finance" at RTU. Prof. Lāce's scientific interests are related to the critical factors of the performance of small and medium-sized enterprises and innovation, as well as various aspects of business finance. N. Lāce is an expert of the Latvian Council of Science in Economics and Entrepreneurship, as well as in political science, she has extensive interdisciplinary professional interests and research experience, which was acquired by leading scientific projects "Development of Innovation and Entrepreneurship in Latvia Supporting the Smart Specialization Strategy" (VPP EKOSOC-LV), "Strengthening the security capacity of the Latvian residents by increasing the level of their financial literacy (394/2012)" (LCS), "Conducting interdisciplinary research in cross-cultural environment" (ERASMUS), "Development of training methodology for implementation of sustainable development in small and medium-sized enterprises based on the life cycle of the company" (RTU, MES), etc. 8 PhD students under the leadership of N. Lāce successfully defended their PhD Theses. Currently, she supervises 5 PhD Theses. Published works (2013 - 2019): 2 scientific monographs, 1 chapter of the scientific monograph (indexed in WoS), 60 scientific articles in international publications, 3 books. Since 2005, 46 scientific articles have been included in the Web of Science data base; 47 – in Scopus data base. H-index – 5 (WoS)/h-8 (Scopus).

Asociētā profesore Airisa Šteinberga. Professional experience: pedagogical experience and development of study programs in different psychology-related subjects (psychology, cognitive and social psychology, pedagogical psychology, etc.) for over 25 years, development of pedagogical enhancement course programs and learning activities, and lecturing thereof at RTU for more than 10 years. Regular professional advancement as a psychologist, work as a counselling psychologist, the long-term academic experience also allows enriching curricula of the study courses, whereas pedagogical style and personal attitude also help to diversify the lectures, hands-on training and learning tasks. Research experience in co-projects with researcher of the Engineering Science Institute allows understanding and using the examples and terminology in the mode understandable for the students. A. Šteinberga's qualification meets the requirements of the study program and regulatory enactments, and ensures achievement of the aims and learning outcomes of the study program and the study course "Psychology of organizations".

Assistant Professor Iveta Ozoliņa-Ozola has 27 years of pedagogical experience. She participates as an expert and researcher in human resources management and economic research. The PhD Thesis "Personnel Turnover Problems and Management Solutions in Enterprises" was publicly presented in 2017, research interests mostly concern the issues related to personnel management. Regularly participates in international and national projects, participates in upskilling activities for the development of pedagogical and human resources management and economic competencies.

Professor Irina Voronova Professional experience: Member of the Latvian Association of Actuaries (1998) and Member of the Board (2002), conducts seminars on the following topics "Methods of risk analysis of economic sectors and their practical application in the audit work process" in the State Audit Office and "Criminal law approach to analysis of accounting documents" in the Association of Administrators (2019), participates in professional conferences with reports and publications in professional journals. Work at the Latvian Actuarial Association ensures knowledge of the latest trends and methods in the field of risk management. The research component of work with students is ensured by participation in scientific conferences and the development of publications related to quantitative methods of risk assessment in insurance and non-financial enterprises.

Assistant Professor Lolita Tīse teaches study courses in accounting and financial accounting. She holds a master's degree in engineering from a business administration specialty. Lolita Tīse has 30 years of experience in pedagogical activities. Participated in seven professional qualification improvement measures for the improvement of pedagogical and financial and accounting related competences.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, renewal of the academic staff has been considered as one of the tasks, which has been completed upon replacement of retiring colleagues with new qualified academic staff. Starting with the academic year 2016/2017, the average age of the academic staff at the program was 49.8 years, but since the academic year 2021/2022 it has been 47.7 years. Generally, the academic staff during the reporting period is estimated as stable. During the reporting period, several associate professors, e.g., Assoc. Prof. Jānis Kampars (2018) and Assoc. Prof. Sergejs Paršutins (2022) were elected for the first time. Three professors retired in the reporting period. Generally, during the reporting period the number of professors decreased as a result of generation change, but the number of associated professors, who previously occupied positions of assistant professors, increased. The total number of involved responsible academic staff during the reporting period was stable.

Academic Year	Professors	Associated professors	Assistant professors	Lecturers and assistants
2013/2014	5	4	4	5
2021/2022	2	6	7	2

The distribution of academic staff is appropriate for the needs of the study program. The proportion of professors and associate professors involved in the implementation of the study program corresponds to the proportion observed in the leading universities in the world. More assistant professors are involved in the study program, as several industry professionals are attracted, who integrate the current trends of the industry into the study process and provide students with industry examples in the topics covered within the study courses.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

In order to achieve the results of the study program, the interlinkage of study courses and their logical, sequential acquisition are important. A system has been established to promote cooperation between academic staff at the faculty and the university as a whole, the system envisions organizing regular academic conferences and professional development seminars for improvement of methodological competences of the staff.

The academic staff of the study program regularly cooperate using various formal and informal mechanisms. The following measures are used for the exchange of experience and information related to the academic activities:

- Meetings of the organizational unit (department, institute) (not less than once every quarter) – at the meetings, the academic staff share their experience in the implementation of study courses. The academic staff discuss cooperation opportunities for improving thematically related courses, as well as discuss the use of different teaching methods, styles and tools to improve the quality of courses.
- Academic conference (once a year) – academic staff of the study program participate in RTU academic conference with their presentations and as listeners. For example, in 2021 the program's teaching staff (Lauma Jokste) delivered a presentation “Improvement of the study process through design thinking, abilities and interactive tools”.
- Seminars, conferences, “brainstorming sessions” and other events.

RTU maintains several electronic platforms where teaching staff can share their experience and best practices:

- E-learning environment – open courses are available in the study environment, which have been created by the academic staff of the program and which provide examples of best practice in the development of e-learning courses. The e-learning environment also offers opportunities for cooperation between the faculty for the implementation of joint study courses, thus providing a chance to efficiently use electronic resources and provide the necessary support to the students;
- E-conference platforms: (appropriately licensed ZOOM and MS Teams) that provide technical support for daily collaboration – for discussions, work meetings and simple exchange of views, which ensures cooperation of academic staff in everyday life.

Improvement of the study courses is carried out on a regular basis, based both on the suggestions expressed by students and on the development trends of the sector. During the implementation of the study courses, regular meetings of the academic staff take place, where they exchange experience on the topics of the study courses, the content of studies is developed and improved in discussions. Academic staff who implement thematically related study courses regularly exchange experience and teaching methods, as well as plan improvements to the related courses. For example, the use of various tools is discussed and aligned both to promote the interactivity of courses (collaborative tools, digital whiteboards) and to complete the tasks of the study program (IT project management tools, etc.). The academic staff regularly review and align the curricula of the related courses so that the courses mutually promote the development of students’ competencies.

The program’s academic staff also participate in several international projects, where the possibilities of improvement of study programs and study courses in a particular field have been offered, for example, in 2021/2022, international projects are being implemented with the aim to draw up recommendations for the development of multidimensional cybersecurity study courses. Within the projects, the academic staff cooperate and exchange experience with employees of foreign educational institutions.

At the time of submitting the self-assessment report, there are a total of 69 students at the program (24 students are in the 1st year, 25 in the 2nd year, and 20 in the 3rd year) and 18 lecturers (for various courses, including those that are taught together with students of other study programs). Thus, student/faculty ratio is 18 / 69 = 0.26.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	47483_ProfesProgr_Diploms DiplomaPielikums ENG.zip	47483_ProfesProgr_Diploms DiplomaPielikums LV.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DGI0(47483)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DGI0(47483)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DGI0(47483)_AtbilstibaValstsStandartam_ProfMag_EN.pdf	P06_3.2.1_DGI0(47483)_AtbilstibaValstsStandartam_ProfMag_LV (2).pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_DGI0(47483)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf	P07_3.2.1_DGI0(47483)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DGI0(47483)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DGI0(47483)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DGI0(47484)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DGI0(47484)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DGI0(47483)_StudyCoursesdescr_ENG.zip	A10_DGI0(47483)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_DGI0(47483)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_DGI0(47483)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Electronics (51523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Electronics*
Education classification code	*51523*
Type of the study programme	*Doctoral study programme*
Name of the study programme director	*Dmitrijs*
Surname of the study programme director	*Pikuļins*
E-mail of the study programme director	*dmitrijs.pikulins@rtu.lv*
Title of the study programme director	*Doktors*
Phone of the study programme director	*+371 67 089 087*
Goal of the study programme	*The aim of the study programme is to prepare highly qualified specialists in electronics who are able to identify and solve current problems in any field of electronics, thus ensuring the effective development or use of new technologies in the design, implementation and operation of various electronic systems related to information processing.*
Tasks of the study programme	*The tasks of the study programme are: - to prepare students for independent research and pedagogical work in a scientific institution or branch company; - to provide competitive knowledge in current world fields in the field of electronics; - to develop student's analytical skills to a level that allows them to identify current problems in one of the fields of electronics and offer possible solutions; - to develop students' skills to conduct experimental research, processing and interpretation of the obtained data; - to develop and improve students' skills to summarize and present research results, to improve the culture of discussion; - to strengthen students' desire to constantly improve their professional knowledge and skills.*
Results of the study programme	*Graduate of the study programme: - is able to independently carry out scientific research and pedagogical work in electronics; - is able to identify, analyse and offer solutions to current problems in any field of electronics; - is able to work individually and in a team doing research work; - manages research methodology and modern research methods; - is able to formulate and present research results (also in a foreign language); - is able and willing to constantly improve their knowledge of electronics; - has defended his dissertation.*
Final examination upon the completion of the study programme	*Publicly defended dissertation.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*Master degree of engineering science, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*
Admission requirements (in English)	*Master degree of engineering science, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The PhD study program in Electronics (hereinafter - the Study Program) has been realised at Riga Technical University (RTU) since the 2001/2002 academic year. The duration of studies is four years. The academic volume of the PhD Study Program is 192 CP, of which 150 CP is the scientific work, including the development and defence of the PhD Thesis. The program is implemented as full-time studies. According to the standard schedule of RTU, each academic year consists of 2 semesters, and each semester lasts for 20 weeks - 16 study weeks and 4 weeks of exam sessions. The study program is implemented in Riga at RTU Institute of Radioelectronics in Latvian and English.

The following significant changes in the parameters of the study program have been implemented since the last accreditation of the study field:

1. the position of the Director of Study Program is now held by Assoc. professor Dmitrijs Pikuļins whose qualification and experience in the development of the content of academic study programs are appropriate;

2. until 2020 the conferred degree was the Doctor of Engineering (Dr.Sc.Ing.), and since 2020 it is Doctor of Science (PhD) according to amendments of the Cabinet of Ministers Regulations;

3. the study program currently is also implemented in English;

4. the compulsory elective study courses in Section B1 have been modified.

The content of the study program has been developed in compliance with the European experience in the development of interdisciplinary study programs and corresponds to the Bologna declaration. It conforms to the European education standards and is adjusted to the current requirements of scientific research institutions and the industry.

The content and implementation of the study program are based on the laws and regulations of the Republic of Latvia, the principles of PhD education recommended by the European Association of Universities, EQUAL Guidelines on PhD studies of May 2016, in compliance with the goals of strategic development of the RTU and the Faculty of Electronics and Telecommunications (FET) and UN Sustainable development goals of higher education.

The changes implemented in the study program since the previous accreditation (2013-2023) are described below. The updated study plan is presented in Section 3.2.1.

Study Program for year 2013			
No	**Code**	Name	**CP**

A		Compulsory Study Courses	15
	REA604	Elements of Solid State Electronics	5
	RRI697	Signal Processing Theory	5
	RTR609	Applied Electrodynamics	5
B 1		Field-Specific Study Courses	21
	RTR604	Numerical Methods and Software for Electromagnetics Engineering	10
	RRI695	Mobile Communications Systems	5
	REA601	Magnetic and Dielectric Spectra of Ferrites	10
	REA602	Measurements in Lumped and Distributed Parameter Circuits	5
	REA603	Technology for Planar Electronics	4
	RRI698	Electronic Technologies	15
	RTR616	Application of Microwaves	5
	REA 700	Scientific workshop	6
C		Free Elective Study Courses	6
E		Final Examination	**150**
	RRI009	Research Work	150
	RRK009	Research Work	150
	RTR009	Research Work	150

Study courses which were excluded from the study program: REA603 Technology for Planar Electronics; RRI698 Electronic Technologies; RTR009 Research Work; RRI009 Research Work.

In turn, the program is complemented by study courses: REA715 Nonlinear Dynamics of Electronic Systems; RTR712 Ultra-Wideband Technology; RTR833 Radiofrequency Wireless Power Transfer.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

Graduates of the study program are highly qualified specialists in electronics who can work at higher education institutions and scientific-research institutes, companies producing electronic devices in Latvia and abroad, public authorities and other organisations related to the industry.

The education required for studies in this study program is the Masterš degree in Engineering or equivalent. Graduates of the study program obtain the degree of Doctor of Science (*PhD*) in the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science.

The study program aims to prepare highly qualified specialists in electronics who can identify and solve current problems in any field of electronics, thus ensuring the effective development or use of modern technologies in the design, implementation and operation of various electronic systems related to information processing. Experts in the field of Electrical Engineering, Electronics, Information and Communication Technologies, in the subfield Electromagnetic Fields and Waves or Circuits and Signals are trained.

The title of the study program, "Electronics" conforms to the field Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science. It is included in the title of the field as its indispensable part.

The duration of the doctoral study program is four years, during which compulsory study courses, compulsory elective and free elective study courses are offered. The compulsory study courses are the same for all the students. However, experts in relevant subfields are trained by elective courses: Electromagnetic Fields and Waves or Circuits and Signals. The academic volume of the PhD Study Program is 192 CP, of which 150 CP is the scientific work, including the development and defence of the PhD Thesis.

The tasks of the study program are:
- to prepare students for independent research and pedagogical work in a scientific institution or branch company;

- to provide competitive knowledge in current world fields in the field of electronics;

- to develop student's analytical skills to a level that allows them to identify current problems in one of the fields of electronics and offer possible solutions;

- to develop students' skills to conduct experimental research, processing and interpretation of the obtained data;

- to develop and improve students' skills to summarise and present research results, to improve the culture of discussion;

To strengthen students' desire to constantly improve their professional knowledge and skills.

Graduate student of the doctoral program "Electronics":

- is able to independently carry out scientific research and pedagogical work in electronics;

- is able to identify, analyse and offer solutions to current problems in any field of electronics;

- is able to work individually and in a team doing research work;

- manages research methodology and modern research methods;

- is able to formulate and present research results (also in a foreign language);

- is able and willing to constantly improve their knowledge of electronics;

- has defended his dissertation.

The content of all study courses is coordinated and linked to the goals and achievable results of the study program, preparing highly qualified electronics specialists who can identify and solve current problems. Study courses provide globally competitive knowledge in the current fields of electronics, develop students' analytical abilities and skills for conducting experiments, and analyze and present the obtained results.

The study program is also implemented in English, targeting international students. All study courses are provided with study materials in English. The description of each study course also indicates the literature in English available in the library. All teaching staff conducting study courses for international students have corresponding knowledge of English.

The program is intended to involve international students who completed one of the master's study programs offered in Latvia, as well as students with a master's degree obtained abroad and an interest in conducting their scientific research in the program's structural unit. Interest in such opportunities is provided by the high scientific qualification of the personnel involved in implementing the program, the relevance of research directions, the scientific projects to be implemented, publications and their citation.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The rapid development of electronics has been seen during the last decades, both in Latvia and globally. The production volumes, the number of employees, the wage level, profit and other characteristics have been improving every year, thus attesting to the growing role of electronics in the economic growth and development of fields of the national economy of many countries.

The PhD Study Program "Electronics" prepares highly qualified international level specialists (doctors of science) in the field of electronics by providing theoretical and practical knowledge required for independent scientific-research work and its management, development of new technologies and use for design and operation of various electronic systems related to information processing, as well as in teaching work.

The content and implementation of the study program is based on the laws and regulations in force in the Republic of Latvia, the principles of PhD education recommended by the European Association of Universities, EQUAL Guidelines on PhD studies of May 2016, in compliance with the goals of strategic development of the RTU and the Faculty of Electronics and Telecommunications and United Nations Sustainable development goals in higher education. The study program's unique character is based on the performance of interdisciplinary research on microwave technique, wireless energy transmission, ultra broadband technologies, smart electronic systems, and non-linear dynamics of electronic systems.

The intellectual potential needed for securing the country's economic development is developed within PhD studies. In compliance with the document "Sustainable Development Strategy of Latvia 2030", long-term investments in human capital are needed to promote the renovation of human resources. Therefore, the demand for specialists holding PhD degrees in the Latvian labour market is very high. The employment of graduates is the primary indicator confirming this demand.

Graduate of the PhD Study Program can establish their own high technology start-up companies and lead Latvian and European scientific and engineering projects in Electronics both in the industry companies and scientific institutions. Graduates of the study programme are highly qualified specialists in electronics and work in Latvia and foreign higher education institutions, research institutes, electronic equipment development and production companies, state institutions and other organisations related to the electronics industry. Graduates are employed at, for example: Riga Technical University, Institute of Electronics and Computer Science, Ventspils International Radioastronomy Centre, SIA "ADI", SIA "HansaMatrix Innovations", AS "SAF Tehnika", SIA "Eventech", etc.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

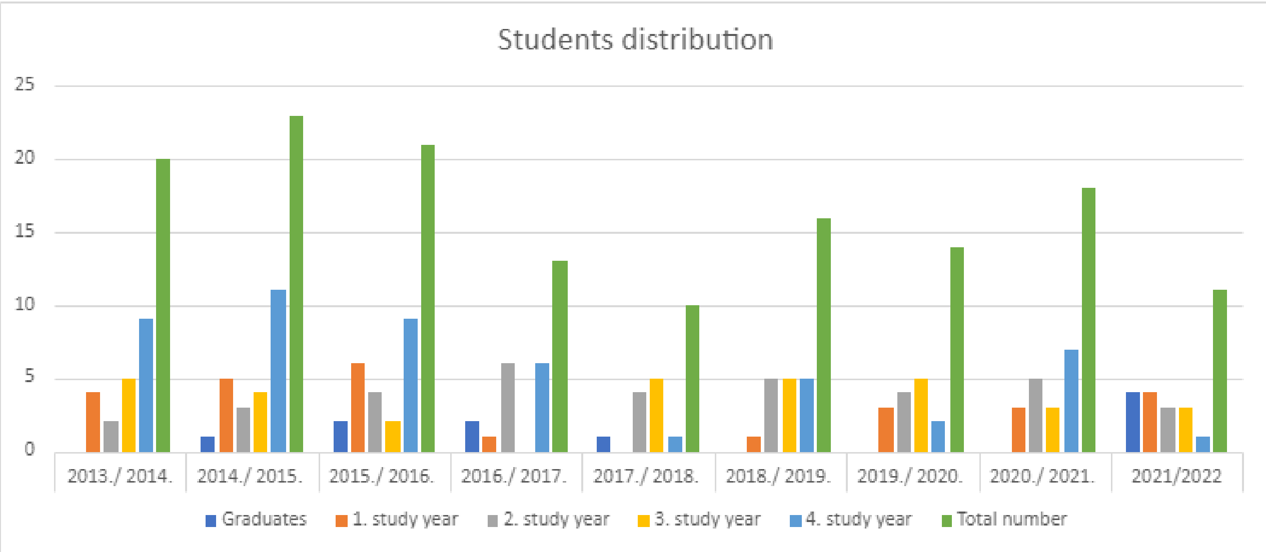
The doctoral study process is based on the individual plan of the students. It is adapted to the specifics of each student's study, including various factors: family circumstances, mobility and internship abroad, involvement in research projects and pedagogical work, career in industry, ERDF doctoral grant funding program ended in 2013, COVID factors caused by the pandemic, such as restrictions on in-site activities, lack of electronic components on the market, etc. Due to the mentioned reasons, doctoral students often take academic leave, interrupt their studies, and do not defend Thesis at the end of the 4th year. Some of the students continue to develop their Doctoral Thesis even after completing the study process. Considering the study process's high adaptation ability, a large number of impact factors, the low total number of students, the summarised distribution of students is not statistically informative. Fluctuations in the total number of students are directly related to the specifics of the study process organisation. However, it should be noted that during the reporting period, the average number of students admitted is 3, while the average number of graduates is above 1, which is a sufficiently high indicator in our industry.

To facilitate the admission, academic performance improvement and graduation of students, several activities are carried out:

- active cooperation with leading representatives of the industry to promote the enrolment of new doctoral students and the overall supervision of doctoral students by attracting one supervisor from the industry (EDI, Hanzamatrix, Eventech) and another one from RTU;
- a program of scientific seminars has been introduced, aimed at supporting and improving the quality of scientific activities of the doctoral students, assessing the progress of students' scientific activities, and exchanging the experience of senior students with inexperienced students;

- RTU SAM project funding for doctoral student grants for both 1st and 2nd year to attract new doctoral students and for the 3rd and 4th year is focused on the defence of doctoral theses;
- active involvement of doctoral students in scientific research projects, the number of which has significantly increased at the Institute of Radioelectronics during the last three years;
- active work with already exmatriculated doctoral student as an applicant for a scientific degree to support the finalisation and defence of the Doctoral Thesis;
- participation of local (RTU) and international (RTUWO, MTTW, RTUCON, AIEEE, ENERGYCON) scientific conferences organised to support the publication of research results of doctoral students;
- active collaboration with European universities, particularly Germany, for admitting 3-4 foreign doctoral students every year beginning with 2022/2023 academic year.

The graph below summarises the distribution of students by study years, the total number, and the number of graduates. The planned number of graduates for the 2021/2022 academic year is 4 doctors, 2 of whom have already defended, and 2 are planned to defend on 10.06.2022. Three out of four doctoral candidates received support from the RTU SAM project. In turn, 4 students in the 1st and 2nd year already have a grant.



3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation

between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The PhD Study Program Electronics (hereinafter - the Study Program) has been implemented at Riga Technical University (RTU) since the 2001/2002 academic year. The goal of the study program is to train highly qualified experts in electronics who are able to identify and solve current problems in any field of electronics, thus ensuring the effective development or use of modern technologies in the design, implementation and operation of various electronic systems related to information processing. Experts in Electrical Engineering, Electronics, Information and communication technologies in the subfield of Electromagnetic Fields and Waves or Circuits and Signals are trained. The duration of studies is four years. The academic volume of the PhD Study Program is 192 CP, of which 150 CP is the research work and the PhD thesis. The structure of the program and all formal conditions comply with state regulations and requirements specified in the decisions of the RTU Senate. The program is constantly being improved by introducing new training courses and adding existing ones.

The summary of the PhD Study Program "Electronics" is presented in the below table.

Study program for year 2022			
	Number	**Title**	**Creditpoints**
A		***Compulsory study courses***	15.0
1	REA604	Elements of Solid State Electronics	5.0
2	RRI697	Signal Processing Theory	5.0
3	RTR609	Applied Electrodynamics	5.0
B		***Compulsory elective study courses***	21.0
B1		Field-Specific Study Courses	21.0
1	REA700	Scientific workshop	6.0
		Electromagnetic Fields and Waves	
1	REA601	Magnetic and Dielectric Spectra of Ferrites	10.0
2	RTR616	Application of Microwaves	5.0
3	RTR604	Elements of Solid State Electronics	10.0

4	RRI695	Mobile Communications Systems	5.0
		Circuits and Signals	
1	REA715	Nonlinear Dynamics of Electronic Systems	15.0
2	RTR712	Ultra-Wideband Technology	15.0
3	RTR833	Radiofrequency Wireless Power Transfer	15.0
4	REA602	Measurements in Lumped and Distributed Parameter Circuits	5.0
C		Free elective study courses	6.0
E		Final / State Examination	150.0
1	RRK009	Research Work	150.0

The studies are based on the PhD student's individual work plan, which is developed by considering the PhD Students' needs and the specifics of the PhD thesis topic. The scientific-research activities are carried out during the whole period of mastering the PhD Study Program.

All the compulsory study courses studied in the first study year improve and strengthen the knowledge in the following subfields: Electromagnetic Fields and Waves, Circuits and Signals Fields and Solid-State Physics. The knowledge of modern signal analysis and synthesis is provided, which allows the use of correlation, coding, and adaptive spectrum processing methods to implement modern equipment and systems. The fundamental knowledge of the electromagnetic field theory is improved, including the basic laws, basic principles, theorems and analytical methods of the macroscopic theory of the electromagnetic field, which are widely used in solving electromagnetic problems. Skills in complex software applications for modelling electromagnetic fields are obtained, which allows for designing equipment and systems based on the employment of electromagnetic radiation. Knowledge of the atomic-crystalline and micro-structures of solids, elements of physical statistics, solid zone structures and kinetic phenomena, and solid-state contact effects are expanded. This improves the competence of being aware of integrated solid-state electronics development trends, micro-and nano-electronics. The acquired knowledge is especially useful when participating in the development of modern integrated circuits or when conducting research on the characteristics and peculiarities of integrated circuits.

During the second study year, compulsory elective study courses are completed in compliance with the PhD Student's needs and the specifics of the PhD thesis topic, as well as free elective study courses. This provides in-depth knowledge and improved competencies in the selected subfield of the PhD Thesis topic: Electromagnetic Fields and Waves or Circuits and Signals. The offered study courses are also based on the scientific results obtained during the implementation of research projects.

The third and fourth study years are devoted to active research activities, PhD Thesis development, and summaries.

As a result of doctoral studies, doctoral students acquire knowledge and competencies that meet the requirements for a doctoral degree and allow them to start relevant research activities.

The program is completed by the PhD Thesis defence at P-08 promotion council.

Terms for completing the PhD studies:

1. RTU PhD studies are completed if successful grades are obtained in all exams of all the study courses included in the study plan; PhD Thesis has been submitted for the defence of the doctoral degree to the relevant promotion council, and the public defence has been done.

2. If the applicant for the scientific degree has independently developed the PhD Thesis and the study results of his/ her preceding education or professional experience have been recognised as conforming to the requirements of the relevant PhD Study Program according to the procedure defined by RTU, he/ she has the right to submit the PhD Thesis for defence.

3. The Doctoral student is exmatriculated as an applicant for a scientific degree after successful completion of the PhD Study Program and the PhD Thesis submission to the promotion council or if the draft of the PhD Thesis has been pre-defended at the meeting of the promotion council or department with the participation of promotion council char and the recommendation has been received to submit the PhD Thesis for review to the promotion council.

4. The Doctoral student is exmatriculated from RTU for academic failure after successful completion of the PhD Study Program if the PhD Thesis has not been submitted to the promotion council, or if the draft version of the PhD Thesis has not been pre-defended at the meeting of the promotion council or department with the participation of promotion council char and the recommendation has not been received to submit the PhD Thesis for review to the promotion council.

5. The Doctoral degree is conferred to a person after a successful defence of the PhD Thesis at the promotion council.

6. The order on exmatriculation of the PhD student as an applicant of the scientific degree or a student with academic failure is issued by the Vice-Rector for Science of RTU based on the decision of the council of the Institute or Faculty.

7. The order on conferring the scientific Doctoral degree and the person's exmatriculation from RTU is issued by the Rector of RTU based on the decision of the promotion council on conferring the scientific degree.

8. Based on the order on conferring the scientific Doctoral degree to the PhD student, the Science Vice-Rector of RTU issues an order on preparation of the Doctoral diploma. The Doctoral diploma is signed by the Rector of RTU and the chairperson of the relevant promotion council.

The prepared PhD Thesis is submitted to the promotion council, which, in compliance with the regulation of the Cabinet of Ministers of Latvia, arranges a meeting where reviewers are assigned, the date for the defence of the PhD Thesis is determined. Then the PhD Thesis is submitted to the State Scientific Qualification Committee. After receiving a positive review, the Thesis is defended, and with a positive vote of the council members, the degree of Doctor of Science is conferred.

The content of all study courses is coordinated and linked to the goals and achievable results of the study program, preparing highly qualified electronics specialists who can identify and solve current problems. Study courses provide globally competitive knowledge in the current fields of electronics, develop students' analytical abilities and skills for conducting experiments, and analyze and present the obtained results.

The content of the study program is regularly updated according to the industry's development trends, the labor market and science, supplementing/modifying the content of individual study courses and replacing outdated study courses with those that provide insight into the most urgent research and industry development problems.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The PhD Study Program "Electronics" is the only program in Latvia that prepares a highly qualified international level experts - doctors of sciences in the sub-fields of Electromagnetic Fields and Waves or Circuits and Signals of the field Electrical Engineering, Electronics, Information and communication technologies, developing the ability to perform high-level fundamental research and to solve high-complexity practical tasks, which are necessary to carry out independent research work and pedagogical work, thereby providing the intellectual potential and renewal necessary for the economic development of the country. The content of the study program and its implementation are based on the current regulatory legal acts of the Republic of Latvia, the principles of doctoral studies recommended by the European Association of Universities, the EQUAL doctoral guidelines of May 2016, and comply with the goals of strategic development of the RTU and the Faculty of Electronics and Telecommunications and UN Sustainable development goals in higher education. Graduates of the study programme receive the degree of the Doctor of Science.

In the study program, there are both state budget funded seats and tuition fee covered seats. The costs of the study program have been calculated in compliance with the established practice at RTU and do not exceed the costs of the EU countries for the training of one student in the relevant speciality.

The study program was developed and is being improved in compliance with the RTU strategy and RTU research program. The task of the RTU Strategy and Development Program 2021-2025 is to implement the priority included in the National Development Plan 2021-2027 "Knowledge and skills for personal and national growth". The study program allows the training of Doctors of Science who will work in various Latvian and foreign undertakings, universities, research institutions and other organisations where research knowledge, skills and competencies in electronics are required.

The study program conforms with the priorities of the RTU Strategy and Development program:

- Internationalisation – university activities in the fields of science, innovation and studies competitive on the international level;
- Interdisciplinarity – cooperation among various fields and specialisations as the basis for creation of new and innovative products and contemporary study content.

RTU Institute of Radioelectronics has successfully internationalised the Bachelor and Master study programs in electronics. At present, the PhD Study Program is also implemented in English.

The goals defined by the descriptions of study courses are closely related to the results to be achieved within the framework of the entire program. The content of the courses is fully consistent with the achievement of learning outcomes. The content of study courses is regularly reviewed and improved, which helps control and update the training content and teaching methods and update the results to be achieved.

The main research fields of the program are based on the FET development strategy, and the main subfields are energy-efficient solutions for highly secure wireless sensor networks.

Certain areas of research are developed within the scientific projects of different levels, as shown in

Subsection 3.4.4. To achieve the research objectives, both in projects and in research areas, students of other levels - bachelor's and master's programs - are also involved with theses, supported by research grants, or employed as research assistants. In turn, doctoral students also participate in teaching activities, contributing to the improvement and development of undergraduate and graduate educational programs, supplementing them with new results obtained in research, managing laboratories and practical work, giving lectures or supervising and advising on final theses.

During the implementation of the study program, courses related to current research directions and open problems are studied, and intensive scientific-research work is carried out, making scientific publications and the development of a doctoral thesis. According to RTU's regulations for doctoral students, every year, the student must publish several scientific publications of the appropriate level. With each year of study, the requirements regarding publications increase, ensuring the publications in high-ranking scientific publications and high citation, promoting the recognition of scientific research. All students regularly participate in international scientific conferences and approve the results of their work. Also, all students of the doctoral program are allowed to submit and participate in the implementation of various scientific projects related to the topics of doctoral theses developed by students.

Doctoral students also involve master's and bachelor's study program students in the realization of their research, offering appropriate topics for the final thesis, contributing to creating a "critical mass" in their research direction, and attracting new researchers.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study program aims to train highly qualified experts and scientific personnel in Electrical Engineering, Electronics, Information and communication technologies in the subfield of Electromagnetic Fields and Waves or Circuits and Signals, capable of performing high-level fundamental research and solving highly complicated practical tasks.

The PhD study program “Electronics” is implemented by considering the diversity of students and the diversity of the forms of implementation of studies, applying various teaching methods, and promoting mutual respect and possibilities of providing feedback. In this way, compliance with the principles of student-centred education has complied.

Persons who have received a Master degree in Engineering sciences are admitted to the study program. The study program is implemented in Latvian and English for four years. The minimum required level of knowledge of English for admission for studies in English is B2. The teaching staff involved in the study program have compliant knowledge of English. The program in English is fully equivalent to the program implemented in Latvian.

The studies are based on the PhD student's individual work plan, which is developed considering the PhD Student's needs and the specifics of the PhD Thesis topic. Within the scope of compulsory study courses during the first year, students strengthen their base knowledge in the subfields of Electromagnetic Fields and Waves, Circuits and Signals, Solid-State Physics. During the second year, they improve their knowledge and competence in the subfield selected according to the PhD Thesis topic on compulsory elective study courses. The third and the fourth study years are devoted to active research activities, development and writing of the PhD Thesis.

The teaching methods, the structure of study courses, and the assessment methods are selected by the teaching staff responsible for the study course in compliance with the specifics of the content of the study course and the study program, as well as students' needs. The methods used to implement the courses include lectures, laboratory exercises, practical exercises, study projects, home exercises, independent work, consultations, and testing. The teaching staff introduces the program and specific evaluation criteria of each study course during the first class and publishes them in the e-study environment of the study course on the RTU portal ORTUS.

Assessment of study outcomes at RTU is performed in compliance with the "Regulation on the Assessment of Learning Outcomes" (only in Latvian) (https://www.rtu.lv/writable/public_files/RTU_1_studiju_rezultatu_vertesanas_nolikums.pdf) and the PhD Studies Regulations of Riga Technical University (only in Latvian)(https://www.rtu.lv/writable/public_files/RTU_4.4._rtu_doktoranturas_nolikums_25062012.pdf. According to the above, examinations in compulsory and compulsory elective study courses are taken with the examination committee consisting of at least three teaching staff members. One is the staff responsible for the study course, and the other two are Doctors of Science.

Courses and workshops on modern teaching and study methods are organised for the academic staff. Attend qualification improvement courses at the internal faculty events and on RTU and international levels is encouraged. RTU Centre of Academic Excellence organises teaching staff improvement events at the university level. Improvement of the qualification of the academic personnel on the international level is ensured by the participation of RTU in ERASMUS+ program (only in Latvian)(https://www.rtu.lv/lv/internacionalizacija/mobilitate/erasmus).

Students can schedule their study process independently in agreement with their PhD Thesis supervisor. This includes mobility programs and internships at foreign universities or in the industry. Attainment of the suggested outcomes of the scientific activity is planned by the PhD student jointly with the supervisor of the PhD Thesis. Regular presentations are made at the scientific workshops of the Institute and within the compulsory elective study course "Scientific workshops". The attained progress in study courses is recorded in the section of completion of the work plan, and the completion is confirmed by the FET Science Commission.

The progress of development of the PhD Thesis is controlled on two levels:

- regular meetings with the supervisor of the PhD Thesis;
- reporting at the institute meeting (minimum once during a study semester).

The study program is implemented in close cooperation with the supervisors of the PhD Thesis. In addition to the above, semester reports are presented at the institute meetings and at the attestation of PhD students at the end of the study year (in compliance with the RTU PhD studies regulations). The PhD student is admitted to the next study year based on the order of the Faculty Dean in accordance with the decision of the Faculty Science Commission and by complying with the following minimum requirements regarding the preparation of publications and development of the PhD Thesis:

1. The PhD student in the first year has published one scientific article, or it has been accepted for publishing, and successfully completed all the compulsory courses.

2. The PhD student in the second year has published at least one scientific article and another scientific article is accepted for publishing, the progress of development of the PhD Thesis is equal to 30% of the total scope of the work, successful completion of all the compulsory elective courses.

3. The PhD student in the third year has published a minimum of two scientific articles, and another scientific article is accepted for publishing. The progress of the PhD Thesis development amounts to 70% of the total scope of the work.

4. At the end of the fourth year PhD students have to do pre-defence of their PhD Thesis at the Institute commission and representatives of the promotion council, resulting in recommending the PhD Thesis to defence.

The PhD Thesis are defended at the promotion council "RTU P-08", which is entitled to confer the scientific doctoral degree Doctor of Science (PhD) in the sub-fields Electromagnetic Fields and Waves or Circuits and Signals of the field Electrical Engineering, Electronics, Information and communication technologies.

The study program is also implemented in English, targeting international students. All study courses are provided with study materials in English. The description of each study course also indicates the literature in English available in the library. All teaching staff conducting study courses for international students have corresponding knowledge of English.

The doctoral study process is based on the principles of student-centered education: doctoral students are involved in improving the study process and content, appropriate study methods are chosen. Doctoral students are also involved in pedagogical work in managing both the bachelor's and master's study process.Faculty counseling, teamwork available. An appropriate environment, which includes aspects such as study and research facilities and equipment, software, and the general campus environment. Scientific research activity in international projects, presentation of achieved results at international scientific conferences, exchange of experience, etc.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Not applicable.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

The PhD academic study program "Electronics" comprises research, development and application of various modern smart modules or systems. The studies are based on the PhD student's individual work plan developed by considering the PhD Student's needs and the specifics of the PhD Thesis. The central part of the study process is devoted to scientific activity. The elective study courses to be completed conform to the following subfields of Electrical Engineering, Electronics, Information and Communication Technologies: Electromagnetic Fields and Waves, Circuits and Signals. Study courses are completed within two academic years and the third and fourth years of studies are devoted to developing and preparing the PhD Thesis. Research work and active development of the PhD Thesis are performed during the whole period of PhD studies with the support of the scientific supervisor and the science commission of the faculty. The PhD student presents the progress of development of the PhD Thesis and summarises the research results in at least one scientific article every year. During the studies, scientific seminars are organised to present the PhD students' research studies and discuss them. At the end of the fourth study year, the pre-defence of the PhD Thesis is organised for the PhD student at the meetings of the council of the Institute of Radioelectronics with the participation chair of the promotion council "RTU P-08". The theses defined in the PhD Thesis, the envisaged tasks, performed research and attained results are presented. If the above presentation is positively evaluated, a recommendation is issued to submit the PhD Thesis for review to the promotion council "RTU P-08". Following a positive decision, the promotion council assigns possible reviewers, sets the time and venue of defence and forwards the submitted PhD Thesis to the State Scientific Qualification Committee.

Various resources and possibilities are offered to ensure the development of the PhD Thesis:

- ***Compulsory and free elective study courses*** that improve competencies and skills within a particular subfield;
- RTU ***e-data bases*** for provision of access and study of scientific literature;
- ***Laboratories of the Institute of Radioelectronics with the necessary equipment*** for performing research activities, experimental research, development of prototypes, and verification of theoretical models;
- ***close cooperation with the industry*** – for provision of topical topics for PhD Thesis, the performance of experimental research by applying the equipment provided by industrial partners, for provision of approbation of the research results, dissemination and commercialisation of obtained research results;
- ***scientific seminars*** - to share and discuss defined hypotheses, research plans, obtained research results, and the most recent achievements in the industry;
- ***active cooperation with the supervisor of the PhD thesis*** for effective development of methodology, models, experiment plans, preparation of the PhD Thesis and scientific publications;
- ***cooperation with other European universities, including ERASMUS+ exchange,*** to ensure mobility of PhD students, internships in other universities, development of post-PhD research projects and implementation of projects, reviewing of PhD Thesis, etc.;
- ***involvement of students in research projects*** to encourage the involvement of students in the research directions of the Institute, to improve the competence of PhD students, to contribute to the development of PhD Thesis;
- ***PhD students' grants and scholarships*** to provide financial support to research work performed by PhD students;
- ***innovation support grants*** to support the most perspective developments;
- ***opportunities to get involved in the study process, including supervision of final theses*** to improve the professional skills and to disseminate the research results;
- ***qualification improvement seminars*** to provide acquisition of new professional knowledge and skills.

Thus, implementation of the PhD study program and attainment of study outcomes are ensured.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Supervision of PhD Thesis is mainly provided by RTU Doctors of Science possessing the entitlement of the expert of the Council of Science of Latvia. However, often there is another supervisor/ adviser of the PhD Thesis. It can represent another scientific institution (for example, Latvian University, Institute of Electronics and Computer Science, Ventspils Highschool) or a company representative. Thus, the topics of the graduation papers developed by students are related to the basic directions of the research work and scientific projects implemented by RTU (and other scientific institutions), as well as the research projects related to the industry's needs. This is what determines the extent and diversity of topics.

Information about the PhD Thesis topics defended during recent years is summarised in the table below.

Defended PhD Thesis	
Title of the Thesis	**Field of Science**
2014.-2015.	
• *Improving Date Transmission Efficiency in Wireless AD-hoc Network*	Circuits and signals
• *Study of Frequency and Microstructure Dependencies of Magnetic Losses of Ferrite Materials and Components*	Fields and waves in electronics
2015.-2016.	
• *Multi-Planar Volumetric 3D Visualization System Model Analysis and Implementation in FPGA*	Circuits and signals
2016.-2017.	
• *Efficient Methods for Detection and Characterisation of Moving Objects in Video* • *Use of Chaotic Sequences for Data Transmission Systems* • *Asynchronous data acquisition of electroencephalogram signals*	Circuits and signals
2021.-2022.	

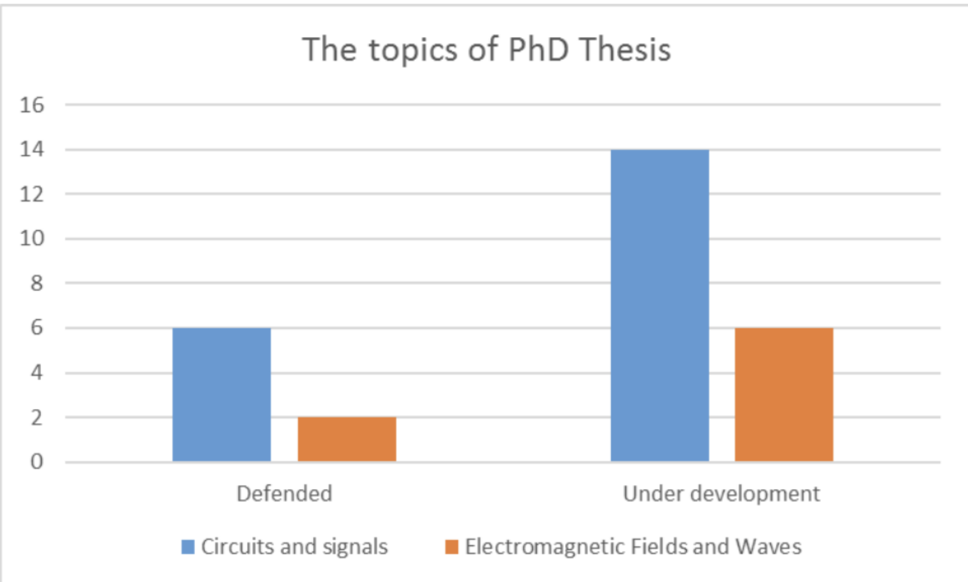
• *Operating Methods of High Voltage Bistable Smart Glass Electronics Systems*	Fields and waves in electronics
• *Implementation of stereo-vision algorithms in heterogeneous embedded systems*	Circuits and signals

Information about the topics of the PhD Thesis under development is summarised in the below table.

PhD Thesis under development	
Title of Doctoral Thesis	**Field of science**
• Measurement models of complex dielectric and magnetic permeabilities with improved sensitivity to measurable values • Low power energy transfer • Power control in thermoelectric systems • Development of microwave filters and determination of the parameters of a layered cylindrical sample • Development of the edge method and its application for optimisation of accuracy and speed of calculations of wave conductor filters • Development of the slicing method and its application to optimise the accuracy and speed of calculation of waveguide filters • Optimum measurement of dielectric materials and use of these materials for filter design in the 60-100 GHz range	Electromagnetic Fields and Waves

• Application of intelligent robotic solutions for data collection and processing to optimise the maintenance of engineering and communication infrastructure • Implementation of an FPGA/ASIC image analysis system based on generalised Haar functions • Method for Obtaining Characteristic Features for Detecting and Recognising Objects in Images • Development of a single fiscal solution for online processing, storage and control of data • Development of neuromorphic computing systems using programmable logic arrays • Data collection and processing of human body sensor network • The hybrid chaotic communication system • Study of applications of nonlinear dynamics and chaotic modes in the operation of electronic equipment • Study of the possibilities of development and application of neural networks for processing 3D data • Methods of creating data sets for training artificial neural networks • Implementation of high-performance the Internet of Things equipment in integrated circuit technology • Research and development of intelligent control methods for industrial robots • Reconstruction of human speech based on electroencephalogram signals • High-Performance Low-Power Transceivers for Wireless Sensor Networks	Circuits and signals

All the information regarding the topics of PhD Thesis can be summarised in a graph.



Distribution of the topics of PhD Thesis

The distribution presented in the figure clearly shows that all the PhD Thesis have been developed in compliance with the science fields defined in the PhD Study Program. However, it is evident that there are many more defended PhD Thesis and PhD Thesis under development in the subfield "Circuits and Signals". As already mentioned, the development of a PhD Thesis in cooperation with an adviser/ supervisor outside RTU is supported, giving doctoral students more opportunities to choose topics and solve current problems of companies in this field. The majority of cooperation partners (HanzaMatrix Innovations, Institute of Electronics and Computer Science, Ventspils University, SAF Tehnika) are engaged in scientific research related to developing various types of signal processing algorithms. Therefore, the total number of Thesis developed in this field is higher. In recent years, the number of scientific projects related to signal processing assigned to RTU has increased, and PhD students are involved in their implementation.

The defence of at least 6 more PhD Thesis is scheduled from 2022 to 2023 (Circuits and signals - 4, Electromagnetic Fields and Waves - 2).

The relevance of the selected topics for a PhD Thesis is evidenced by reviews of defended PhD Thesis and scientific articles published by doctoral students and their citations.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

All the available resources can be divided into centralised (for example, RTU Scientific Library and electronic database subscriptions, etc.) and the study program specific resources that supplement the centralised resources. This section describes the specific resources for implementing the PhD Study Program "Electronics". The study program is implemented on the RTU Faculty of Electronics and Telecommunications (FET) premises. Renovation works were performed at FET; therefore, the Faculty conforms to international standards for providing high-quality study process. Equipment of lecture rooms and training laboratories is continuously updated, corresponding to the industry development trends.

To implement the courses of the study program, the teaching staff of the FET - doctors of science from the following structural divisions are involved:

- Departments of Electronics Basics;
- Department of Electronic Devices;
- Department of Radio Devices.

In the part of the free elective study courses, students have the opportunity to master the content of the proposed training courses outside the above listed structural divisions.

Relevant structural divisions ensure the development and improvement of educational materials, the management of lectures, laboratory and practical classes, and other educational and methodological activities. The academic staff of FET is also responsible for supervising PhD

Theses.

Also, the general RTU staff is available for the implementation of the study program and supports the functioning of the infrastructure. Implementation and maintenance of the study program are ensured by the administrative staff consisting of the study office administrator, secretary and technical staff. Management of international students and coordination of the study work is done by the RTU International Cooperation and Foreign Students Department.

To perform laboratory and practical exercises FET has access to specialised study laboratories with the modern equipment and software needed for mastering relevant practical skills within study courses. In addition to the basic study laboratories, students can use the specialised research laboratories located at the FET premises and as these are especially important for PhD studies:

- Wireless sensor network (WSN) and software-defined radio (SDR) laboratory;
- Laboratory of electroacoustics;
- Prototyping laboratory;
- Electronic devices testing centre of Latvia (LEITC).

Detailed information about scientific laboratories and available equipment is provided in Subsection 3.3.2.

Independent access to the information base and operative data exchange during PhD studies is essential. A high level of digitalisation supports students with the modern, reliable, secure IT infrastructure and high-quality IT services.

All the IT users have access to the centralised portal ORTUS (https://ortus.rtu.lv/), which operates as a single digital gateway comprising information from all the parts of the RTU information systems and provides convenient and easy access for users to all the IT service catalogue from a single spot.

Moodle e-study environment is used to efficiently implement the study process, where all the mandatory information is prepared automatically (study courses, users, groups, access rights, etc.). Within this system, the communication between students and teaching staff is ensured. The teaching staff posts e-materials, tests, home assignments, information about the process of a particular study course, etc., in the system. In the ORTUS portal, students can also see their relevant financial information and request documents (statements, academic progress reports, copies of the contract, etc.).

The study classes and schedules have been digitalised to efficiently manage premises and plan studies (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Any student or teaching staff member can view their schedule of classes where the venue, time, professor, room, the title of the course and type of the course can be seen for every class.

A digital student survey system is used to ensure quality. The semester quality control is performed for particular study courses, and the study program quality control is done. Based on the quality control results, regular improvement measures of the study process are implemented.

In addition, for the convenience of the RTU students, teaching staff and employees, RTU is leasing ***Microsoft Windows and Microsoft Office software***. It provides access to the most recent and modern Microsoft software for all users, including RTU students that can use the licensed operating system Windows and the productivity package Microsoft Office provided by RTU. All the RTU users have access to ***Microsoft Office 365 cloud computing platform,*** and 1TB of disk space is provided to every user and access to various additional shared operation and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.). RTU students, teaching staff, and employees have access to provided e-mails.

A centralised Science support system was developed to support scientific processes, where all information on publications, patents, commercialisation applications, PhD Thesis, RTU scientific magazines, scientific personnel, etc. The system provides access to information on the principle of ***OpenAccess*** (https://science.rtu.lv). In addition to the above, RTU students and teaching staff have access to scientific software.

RTU Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka) is a national library that has obtained this status due to library accreditation. RTU Scientific Library provides the necessary information for the RTU study process and research activities and provides a library, bibliographic and information services to RTU students, teaching staff and employees. The library stock consists of 1.4 billion printed documents and e-resources in the databases relevant to RTU fields.

In 2016 significant investment was made into the library infrastructure development to build additional premises with the space of 2240 m2 for the Central Library. The total area of the library premises is 6393 m2, of which the readers' service rooms amount to 3417 m2. The library users have access to 713 workplaces. There are four group rooms in the library, six individual cabins, the West reading room, and a conference room. The library is also accessible for users with reduced mobility.

Databases subscribed by the RTU Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/abonetas-datubazes):

- ***EBSCOHOST eBook Academic Collection*** - E-book full-text database eBook Academic Collection contains ~202 200 books in various fields of science: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.
- ***IEEE Xplore Digital Library*** (IEEE/IET Electronic Library) - IEEE Xplore Digital Library is the most extensive pack of databases. All the IEEE/IET full-text magazines, conference materials, scientific collections and standards are available.
- ***E-magazines*** and e-book search - SFX software is used to identify the exact location of e-resources (e-magazines, e-books) in the databases subscribed by the RTU Scientific Library and free-access databases.
- ***SpringerLink*** database e-books provide access to 18,500 e-books (published in 2014 -2020). Fields: computer sciences, engineering sciences.
- ***Web of Science*** is the leading research platform of electronic resources. The single platform provides integrated access to high-quality literature sources, includes information search in bibliographic (with a citation index) databases, helps to find the most recent and essential scientific publications in magazines with a high impact factor, conference materials, etc., as well as presents the citation of scientific publications.
- ***Latvian Standards database*** content: The Latvian national standards (LVS); the European standards adopted as the Latvian standards (EN); the international standards adapted as the Latvian standards (ISO); annexes to standards: amendments and corrigenda. The thematic arrangement corresponds to the internationally accepted classification of standards ICS (International Classification for Standards). Standards can be searched by number, and they are available for reading.
- ***EBSCOHOST - EBSCO*** databases contain periodicals of computer science, natural sciences, engineering sciences, humanities and social sciences, economics, business, medicine and other fields.
- ***ProQuest Ebook Central*** (previously Ebrary) database provides an opportunity to read

scientific books in an electronic format. ProQuest Ebook Central platform provides access to the collection of electronic books "Academic Complete" consisting of approximately 200,000 e-books in English as PDF files published by the leading scientific publishing houses – Elsevier, Wiley, Springer, Oxford Press, Emerald, etc.

- ***ScienceDirect*** is among the most extensive global databases of scientific, technical and medical articles containing the full texts of magazines of the publishing house Elsevier Science.
- ***SCOPUS*** (by Elsevier) – the bibliographic citations database of research literature, created for scientists for fast access to information.
- ***ACM Digital Library*** offers high-quality publications in computer science - security of computer hardware, computer graphics, obtaining of information, mobile technologies, software engineering, etc.
- ***WILEY Online Library*** data base provides access to the full texts of edited magazines package "Full Collection".
- ***Letonika*** is the Latvian reference and translation system on the Internet. Its primary goal is to provide systematic, comprehensive reference and translation information by creating new digital resources about Latvia and collecting the existing ones in the same place.
- Repository of study materials ***MERLOT*** is the most significant global repository of free of charge study materials comprising more than 28,000 materials and providing the possibility to add own study materials. There are also links to more than 500 other repositories of study materials, creating unlimited possibilities for reviewing online study materials.

The librarian on duty helps to find the relevant sources. Bibliographs (information specialists) provide more detailed information and consultations about the searching process. In the library, there is the industry librarian's service (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija).

The search of the library resources is provided by the search tool Primo Discovery (https://www.rtu.lv/lv/studijas/biblioteka/vienota-informacijas-meklesana). This allows using a single interface for searching for information in the library catalogue (https://kopkatalogs.lv/F/?func=find-b-0&local_base=rtu01), in the subscribed databases, as well as the databases developed by the RTU Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/bibliotekas-veidotas-datubazes). In the course of searching for information in the electronic common catalogue (https://kopkatalogs.lv/F), it is possible to obtain information about available resources at 12 libraries in Latvia at the same time. Both in the electronic catalogue and the RTU portal ORTUS it is possible to book library resources remotely; also, remote access to databases is provided. Since the introduction of RFID technology, users can use five self-service, automated machines for receipt and delivery of books and return books in the delivery-sorting machine 24 hours a day.

The library provides various individual consultations and group training to develop information literacy for students, the academic staff and other interested persons(https://www.rtu.lv/lv/studijas/biblioteka/lietotaju-apmacibas).

Materials unavailable at the library are delivered using the inter-library or International subscriptions.

The information provided under criteria 3.1-3.3 of Section 3 of Part II of the Study Direction Report presents the overall resources assessment.

3.3.2. Assessment of the study provision and scientific base support, including the

resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Access to modern software and equipment resources in specialised laboratories plays a decisive role in implementing the PhD Study Program. During the PhD studies, students use laboratories accessible within RTU and resources of cooperation partners (companies and scientific organisations).

The most significant laboratory of the RTU Institute of Radioelectronics is ***"Wireless sensor network and software-defined radio laboratory".***

The laboratory is equipped with tools to perform RF and microwave frequency range measurements. In the laboratory, it is possible to design and validate analog components of RF devices, for example, filters, amplifiers, antennas, receivers/ transmitters. The software-defined radio module set together with MATLAB/Simulink software allows research of various digital modulation methodologies and signal processing issues. The laboratory can provide various services for the industry, starting from the RF network parameter (for example, coordination, frequency response, signal range and signal waveforms) measurements and up to the design of adapted RF modules. PhD Theses related to microwave technique, electromagnetic phenomena, wireless data and energy transmission, chaotic communication, wireless sensor networks, etc. are developed in the laboratory. The major equipment available at the laboratory: Tektronix DPO72004C Oscilloscope (4 analog channels, 20 GHz analog bandwidth, 4x P7520A 20GHz probes, sampling rate of 100GSa/s with 2 channels, 50GSa/s with 4 channels); Tektronix MSO5204B Oscilloscope (4 analog channels,16 digital channels, 2 GHz analog bandwidth, sampling rate of 10GSa/s with 2 channels, 5GSa/s with 4 channels.)Tektronix TDS3054B Oscilloscope (4 analog channels, 500 MHz analog bandwidth, sampling rate of 5GSa/s with 4 channels); Rohde & Schwarz FSP30 Spectrum analyser (9KHz – 30GHz); Rohde & Schwarz SMR30 RF signal generator (CW signal generation with pulse modulation capability, 10MHz – 30GHz frequency); Rohde & Schwarz SMC100A RF Signal Generator Frequency range 9 kHz to 3.2 GHz, Maximum output level of typ. > +17 dBm, Integrated analog modulation modes (AM/FM/φM/pulse); Rohde & Schwarz URV55 Millivoltmeter (for DC and AC voltage, average power, pulse power, max. envelope power measurements, Voltage measurements in frequency range from 9 kHz to 3 GHz, 200 µV to 1000 V, power measurements from DC to 40 GHz, 100 pW to 30 W); Real-Time USB Spectrum Analyzer Spectran HF-80120 V5 X (9kHz – 12GHz frequency range, 88MHz bandwidth) with RF Near Field Probe Set (DC to 9GHz) and EMC Preamplifier PBS2, IsoLOG 3D Mobile 9060Handheld Isotropic Antenna (9KHz – 6GHz frequency), OmniLOG 70600 radial isotropic (omni directional) antenna (680 MHz – 6GHz); Keysight 53220A Universal Frequency Counter/Timer 350 MHz, 100 ps; Agilent E4402B ESA-E Series Spectrum Analyzer (100 Hz – 3.0 GHz); B2901A Precision Source/Measure Unit, 1 ch, 100 fA, 210 V, 3 A DC/10.5 A Pulse, Minimum source resolution: 1 pA /1 µV, Minimum measurement resolution: 100 fA/100 nV; Ettus research USRP B210 (10 pieces) with complete antenna kits; AD-FMCOMMS5-EBZ - high-speed analog module for 4x4 MIMO, 70 MHz to 6 GHz, bandwidths from less than 200 kHz to 56 MHz.; Microwave Trainer WT-9000; LoRaWAN Femtocell Gateways (5 pieces); Sensor network nodes: Sodaque Explorer LoRa sensor nodes (50 pieces), PSoC® 6 BLE Pioneer Kit (10 nodes); STM32L0 Discovery kit LoRa (10 pieces); Microchip LoRa(R) Technology Evaluation Kit – 800.

The laboratory software includes MATLAB/Simulink with relevant blocksets, COMSOL 5.3 (with the RF module), ANSYS Electromagnetics Suite 2019 R1.

Students of the PhD Study Program of the RTU Institute of Radioelectronics also have access to the

Electronic devices testing centre of Latvia (LEITC), located on FET premises. The centre offers consultations and complex testing services in electromagnetic compatibility compliance with more than 25 European Union standards and the Directives. LEITC provides testing and results in reports determining whether a particular product complies with the EU directives. The laboratory services present the main link for obtaining evidence that the product may carry the CE label. In the laboratory, it is also possible to perform research on electromagnetic phenomena in an isolated environment which is not affected by disturbances existing in the environment: communication system research, wireless energy transmission, etc. More details of the possibilities provided by the laboratory and available equipment can be found here: https://www.leitc.lv/en/laboratory#equipment.

In the course of implementation of the scientific work, by solving the assignments on electromagnetic field modelling, and signal processing, PhD students actively use the high-performance computing infrastructure offered by ***RTU HPC centre (Scientific Computing Centre)***, which is a structural unit subordinated to the Science Vice-Rector and whose mission is the promotion and support of the application of digital technologies in research by making RTU and the Latvian science more modern and competitive. The main tasks of the HPC centre are as follows: provision of access to high capacity computing and data storage infrastructure; provision of modelling and simulation services, as well as assistance in transferring assignments to HPC.

Many PhD students develop their graduation projects in cooperation with the Institute of ***Electronics and Computer Science (EDI)***, in compliance with the research directions of this scientific institution. Access to the relevant EDI laboratories is provided to these students, who are usually employed in projects implemented by EDI:

- ***The discrete signal processing laboratory*** is engaged in theoretical research and practical developments of digital signal processing, including the development of specific methods and their application for the signal analogue-digital transformation. In the laboratory, there is available equipment for the implementation of research works in the following thematic directions: modern DSP technology-based virtual tools; software-defined radio devices, including based on uneven discretisation; signal-dependent analysis of non-stationary signals, event controlled analogue-digital transformations; biometeric and brain signal processing; the processing of the face and palm biometric data; microminiaturisation of data collection and processing systems; smart sensor and networked embedded system signal processing; wireless sensor network systems, including sensor modules equipment architecture, communication protocols; operating systems and application-oriented software; directed operation antennas massive applications in wireless sensor networks; transistor UWB receivers and impulse generators; application of the biological feedback in medical rehabilitation.
- ***Space technology laboratory*** has been performing research in high precision event time moment measurement related to predefined signal points for many years. Research in the following directions is performed at the laboratory: theoretical principles of accurate time measurement; development and research of non-traditional signal processing methods; discrete image processing methods and algorithms with high-speed action.
- ***Robotics and machine perception laboratory*** develops technologies allowing computerised systems to perceive the world, interpret it, adopt decisions, and act. The keywords describing the operation of the laboratory are as follows: the Internet of Things, wireless sensor networks, intelligent sensors; signal and figure processing; explainable artificial intelligence; computer vision; machine learning, deep neuron networks, embedded intelligence, edge and fog computing, FPGA, SoC; automation, industrial robots, real-time management, mobile robots.

- ***Cyberphysical systems laboratory***, where research is performed in the areas of prototyping and testing of wireless sensor and embedded system devices, software and operating system development, optimisation and usability, as well as research of smart transportation systems. The particular focus will be on interdisciplinary research opening up a new view of the world and helping to transform it positively.

Some PhD students develop their PhD Thesis in cooperation with ***Ventspils International Radioastronomy Centre*** by using the infrastructure and laboratories of this institution:

- ***High-performance computing department*** is engaged in science and engineering assignments where there are such high computing requirements that it is impossible to perform them by daily use computers. There are three main directions of research: research in engineering physics, radio astronomic data processing, and methodology development research, close space research.
- ***The remote research and signal processing department*** develops specialised methodologies for transforming remote research data into information products, research and testing remote research data processing methods, and software engineering.
- ***Electronics and satellite technology department***, where research is performed in the following three main directions of research:

  - Satellite engineering: satellite communication and software-defined radio; embedded parallel signal processing; high reliability and redundant embedded control systems.
  - Modern antenna technologies: low noise amplifiers of weak radio signals; high performance and compressed perception; aperture, grid and planar antenna technologies; beam formation and optimisation of directed action diagram.
  - Cyberphysical and embedded systems: network and sensor network technologies; smart and wireless technologies; signal streaming, streaming quality provision, machine-machine communication.

In addition to the above, PhD students also develop their PhD Thesis in the industrial companies by using equipment and infrastructure available there: SAF Tehnika, Hansa Matrix Innovation, EUROLCD. During mobility programs PhD students visit partner institutions by performing research and laboratory experiments, for example, CoSa (Lubeck), Vilnius Tech.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU financing from the basic state budget consists of the financing based on the list of study programs and the number of students and it comprises funds for payment of utilities, taxes, maintenance of the infrastructure, procurement of inventory and equipment and staff wages, as well as financing for scientific activities.

The number of state budget funded seats is granted following negotiations with the Ministry of Education and Science. The study base funding from the state budget funds is allocated to full-time studies. The amount of the study base funding is defined based on the number of state budget funded seats at RTU defined by the state, the base costs of a study place defined by the state, and the rates of study costs of the thematic blocks of education. The rates of study costs of the thematic blocks of education are the indices defining the amount of costs of a study seat in the relevant thematic block of education in relation to the base costs of a study seat.

RTU has a decentralised budget, therefore, each structural unit has a separate own budget. In the general sense, the budget is a plan of revenues and expenditure for a particular time period, assignment, event or function. In RTU, revenue and expense are managed according to the principles approved by the Senate or defined by the Vice-Rector for Finance according to his delegated authority.

Financing is allocated to structural units either in compliance with the fiscal or budget year or immediately following receipt of the financing. At RTU every head of a structural unit has remote access to operational financial information on the budget of the structural unit, including the scheduled work load and allocated funding in future periods for implementation of study programs and study courses. Based on this information, in the beginning of every fiscal or budget year, the head of a structural unit plans the works of the structural unit, including wages for the academic staff subordinated to the relevant structural unit head, and develops a procurement plan for the next year for providing implementation of the study program or courses.

The main sources of funds for provision of the program per years are presented in the below table:

Study year	Grant for the program, EUR	Total funding for the program, EUR	Funding for one State budget funded seat, EUR
2013/2014	67,800.00	67,800.00	11,598.00
2014/2015	83,511.17	83,511.17	11,598.06
2015/2016	69,296.20	69,296.20	11,598.06
2016/2017	69,655.13	69,655.13	11,598.06
2017/2018	68,473.27	68,473.27	12,121.97
2018/2019	63,415.72	63,415.72	12,689.04
2019/2020	79,223.45	79,223.45	13,215.13
2020/2021	83,944.91	83,944.91	13,388.43

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "Funding distribution between the cost items"

Information on the minimum needed number of students in the program is presented in the annex to the self-assessment report "On minimal number of students in study programs".

Funding obtained in the program is used to cover daily expenses related to the implementation of the study program (for example, premises, utility payments, etc.). After making the mandatory payments, the remaining funding is used for the development of the study program: literature relevant to the content of the study program is purchased (for Latvian and international students), the existing stock of electronic components is maintained and replenished, new modern development kits for practical lessons are purchased (e.g., microcontroller programming, data transmission systems etc.).

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

Five teaching staff members holding the degree of the Doctor of Science are involved in the implementation of the PhD Study Program Electronics: 1 Professor, 3 Assoc. Professors, 1 Assistant Professor. The Council of Professors has elected all the involved staff members to the positions of Assoc. Professors or Professors and their scientific and teaching qualifications comply with the criteria defined by laws and regulations on assessing applicants' scientific and teaching qualifications for positions. The Faculty Council has elected the Assistant Professor. His scientific and teaching qualifications comply with the criteria defined by laws and regulations on assessing. The study courses provided and jointly provided by the staff involved in the PhD Study Program are summarised below.

The involved staff has a high level of professionalism and possesses the competencies necessary for the work, as also described by Sections 3.4.3 and 3.4.4. Moreover, 40% of the staff also possess industry experience, which allows them to better understand the industry needs, problems to be solved, and requirements set for highly qualified personnel. 60% of the staff hold the LCS expert entitlement, and 40% are independent European experts actively involved in the evaluation of the European scientific activity.

Main information on the teaching staff members

No.	Name, surname	Scientific degree	Position	Term of electing to the academic position	Study courses	LCS expert	European independent expert	h-index
1.	Arnis Gulbis	Dr.phys.	Professor	06.02.2023.	RRK009 REA604 REA700 REA601	21.03.2013-21.03.2015	-	3
2.	Anna Litviņenko	Dr.sc.ing	Assoc. Professor	07.04.2026	RRI697 RTR833 RRI695 REA715	07.11.2018 - until now	2013 - until now	6
3.	Dmitrijs Pikuļins	Dr.sc.ing	Assoc. Professor	07.04.2026.	RRK009 REA700 REA601 REA715 REA602	17.04.2014 - until now	-	7
4.	Ārtūrs Āboltiņš	Dr.sc.ing	Assoc. Professor	27.09.2023.	REA715 RTR712	20.11.2014 - 06.04.2025.	2012 - until now	5

5	Jānis Semeņako	Dr.sc.ing	Assistant professor	07.06.2024.	RTR609 RTR616 RTR604	21.01.2016 - 18.06.2020	-	3

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The distribution of teaching staff in 2022 and 2013 is presented in the relevant tables. In the PhD study process in 2013, there were five teaching staff members involved: 1 Professor, 3 Assoc. Professors, 1 Assistant Professor. The mean age of the staff equalled 67 years. In the PhD study process in 2022, there were also five teaching staff members involved: 1 Professor, 3 Assoc. Professors, 1 Assistant Professor. The mean age of the staff equalled 52 years. Change of generations has taken place and 3 new assoc. Professors were involved, one assoc. Professor got the position of the professor. The teaching staff was changed by including new persons and actively involving them in the scientific activity as supervisors and implementers of scientific projects devoted to modern applications of electronics in the subfields of Signals and Circuits, as well as Fields and Waves in Electronics, which is presented in the two following subsections. This, in turn, provided the possibility to more involve PhD students in the research directions selected by the Faculty and the Institute of Radioelectronics, effectively transfer obtained knowledge and skills, improve the overall staff competence, and provide an opportunity for a further generation change. The total number of students has been stable during the reporting period with some fluctuations, which confirms the professionalism of the involved staff.

Distribution of teaching staff in 2022

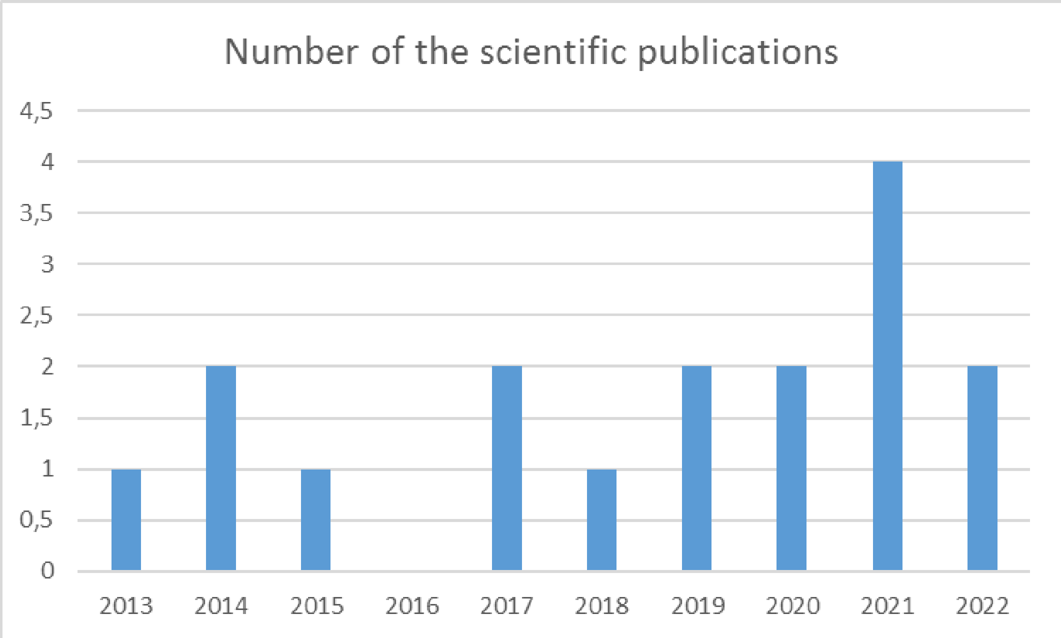
No.	Name, surname	Full years	Scientific degree	Position	Term of electing to the academic position
1	Arnis Gulbis	71	Dr.phys.	Professor, leading researcher	06.02.2023.
2	Anna Litviņenko	35	Dr.sc.ing	Assoc. Professor	07.04.2026
3	Dmitrijs Pikuļins	36	Dr.sc.ing	Assoc. Professor	07.04.2026.
4	Ārtūrs Āboltiņš	47	Dr.sc.ing	Assoc. Professor	27.09.2023.
5	Jānis Semeņako	74	Dr.sc.ing	Assistant Professor, leading researcher	07.06.2024.

Distribution of teaching staff in 2013

No.	Name, surname	Full years	Scientific degree	Position
1	Guntars Balodis	63	Dr.sc.ing.	Professor
2	Elmārs Beķeris	73	Dr.sc.ing.	Assoc. Professor
3	Arnis Gulbis	62	Dr.phys.	Assoc. Professor
4	Jānis Jankovskis	71	Dr.habil.sc.ing.	Professor
5	Jānis Semeņako	66	Dr.sc.ing.	Assistant professor

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

The following teaching staff was involved in implementing the PhD Study Program during the reporting period: 3 Professors, 4 Assoc. Professors, 1 Assistant Professor, totally of 8 teaching staff members. Implementation of the program of both 2013 and 2020 was provided by 5 teaching staff members who were replaced during the reporting period. 16 journal articles indexed in the databases Scopus or WoS were published during this period. From the distribution of the journal publications, it can be seen that the number of publications in the years 2013 -2020 has been stable and accounted for approximately 1.5 publications per year. A positive trend had appeared starting from 2021, when the number of journal publications increased. Articles have been published already in 2022. The increased number of journal publications can be explained by more intense scientific research activity of the involved staff during recent years, as presented in Section 3.4.4. The overall trend of increasing scientific publications also applies to the articles of conference proceedings indexed in Scopus or WoS databases.



List of indexed journal publications:

1. Eidaks, J., Kušņins, R., Babajans, R., Čirjuļina, D., Semeņako, J., Litviņenko, A. Fast and Accurate Approach to RF-DC Conversion Efficiency Estimation for Multi-Tone Signals. Sensors, 2022, Vol. 22, No. 3, Article number 787. ISSN 1424-8220. Pieejams: doi:10.3390/s22030787

2. Babajans, R., Čirjuļina, D., Grizāns, J., Āboltiņš, A., Pikuļins, D., Zeltiņš, M., Litviņenko, A. Impact of the Chaotic Synchronisation's Stability on the Performance of QCPSK Communication System. MDPI Electronics, 2021, Vol. 10, No. 6, Article number 640. ISSN 2079-9292. Pieejams: doi:10.3390/electronics10060640

3. Čapligins, F., Litviņenko, A., Āboltiņš, A., Austrums, Ē., Rušiņš, A., Pikuļins, D. Experimental Study of the Chaotic Jerk Circuit Application for Chaos Shift Keying. Latvian Journal of Physics and Technical Sciences, 2021, Vol. 58, No. 4, 55.-68.lpp. e-ISSN 2255-8896. Pieejams: doi:10.2478/lpts-2021-0033

4. Āboltiņš, A., Grizāns, J., Pikuļins, D., Tērauds, M., Zeltiņš, M. Design of Acoustic Signals for a Seal Deterrent Device. Electrical, Control and Communication Engineering, 2021, Vol. 16, No. 2, 72.-77. lpp. ISSN 2255-9140. e-ISSN 2255-9159. Pieejams: doi:10.2478/ecce-2020-0011

5. Āboltiņš, A., Pikuļins, D., Grizāns, J., Tjukovs, S. Piscivorous Bird Deterrent Device Based on a Direct Digital Synthesis of Acoustic Signals. Elektronika ir elektrotechnika = Electronics and Electrical Engineering, 2021, Vol. 27, No. 6, 42.-48. lpp. ISSN 1392-1215. e-ISSN 2029-5731. Pieejams: doi:10.5755/j02.eie.28977

6. Gulbis, A., Maļinovska, D., Stepins, D., Gulbe, M. A Simple Approach for Determination of Numerical Values of Ferrite Nonlinear Susceptibilities. IEEE Transactions on Magnetics, 2020, Vol. 56, No. 9, Article number 2000706. ISSN 0018-9464. e-ISSN 1941-0069. Pieejams: doi:10.1109/TMAG.2020.3003892

7. Ķimsis, K., Shestopalov, Y., Semeņako, J. Effectively Tunable Bandpass Waveguide Filter Based on Incorporation of Coupled Cylindrical Resonators Cut in Half. Electrical, Control and Communication Engineering, 2020, Vol. 16, No. 2, 78.-87.lpp. ISSN 2255-9140. e-ISSN 2255-9159. Pieejams: doi:10.2478/ecce-2020-0012

8. Eidaks, J., Litviņenko, A., Āboltiņš, A., Pikuļins, D. Waveform Impact on Wireless Power Transfer Efficiency using Low-Power Harvesting Devices. Electrical, Control and Communication Engineering,

2019, Vol. 15, No. 2, 96.-103. lpp. ISSN 2255-9140. e-ISSN 2255-9159. Pieejams: doi:10.2478/ecce-2019-0013

9. Maltisovs, M., Pikuļins, D. Study of Electrical Properties of Bistable Smectic-A Liquid Crystal Displays. Latvian Journal of Physics and Technical Sciences, 2019, Vol. 56, No. 5, 3.-11.lpp. ISSN 2255-8896. Pieejams: doi:10.2478/lpts-2019-0026

10. Maltisovs, M., Krumiņš, K., Ozols, A., Pikuļins, D. Study of the Operational Properties of Bistable Smectic-A Liquid Crystal Displays. Latvian Journal of Physics and Technical Sciences, 2018, Vol.55, No.3, 54.-62.lpp. ISSN 0868-8257. Pieejams: doi:10.2478/lpts-2018-0021

11. Litviņenko, A., Beķeris, E. Statistical Analysis of Multiple Access Interference in Chaotic Spreading Sequence Based DS-CDMA Systems. Electronics, 2017, Vol.21, No.1, 34.-37.lpp. ISSN 1450-5843. Pieejams: doi:10.7251/ELS1721034L

12. Litviņenko, A., Āboltiņš, A. Computationally Efficient Chaotic Spreading Sequence Selection for Asynchronous DS-CDMA. Electrical, Control and Communication Engineering, 2017, Vol.13, 75.-80.lpp. ISSN 2255-9140. e-ISSN 2255-9159. Pieejams: doi:10.1515/ecce-2017-0011

13. Artamonovs, O., Balodis, G. Meshed Patch Antenna for Portable UHF Band Radio Communication Devices. Elektronika ir elektrotechnika, 2015, Vol.21, No.4, 31.-34.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Pieejams: doi:10.5755/j01.eee.21.4.12778

14. Pikuļins, D. Complete Bifurcation Analysis of DC-DC Converters Under Current Mode Control. Journal of Physics: Conference Series, 2014, Vol.482, No.1, 012034.-012034.lpp. ISSN 1742-6588. e-ISSN 1742-6596. Pieejams: doi:10.1088/1742-6596/482/1/012034

15. Pikuļins, D. Exploring Types of Instabilities in Switching Power Converters: the Complete Bifurcation Analysis. Elektronika ir Elektrotechnika, 2014, Vol.20, No.5, 76.-79.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Pieejams: doi:10.5755/j01.eee.20.5.7103

16. Pikuļins, D. Subharmonic Oscillations and Chaos in DC-DC Switching Converters. Electronics and Electrical Engineering, 2013, Vol.19, No.4, 33.-36.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Pieejams: doi:10.5755/j01.eee.19.4.4054

A summary of the scientific activity of the involved staff is presented in the relevant table. Out of 8 employees, 7 were included in the database of experts of the Latvian Council of Science (LCS) during the reporting period in the fields of Power engineering, electronics, information and communication technologies/ Electronics and telecommunications/ Physics. At present, 3 teaching staff members are the experts of the Council of Science of Latvia in Power engineering, electronics, information and communication technologies. The summary of the scientific activity of the staff shows that published articles are also actively cited, which confirms the topicality of the research and the high qualification of the staff. It is worth noting that the newly involved staff demonstrates very high scientific activity indices, and there is a positive trend of increase in the total number of articles and their citations.

Summary of the scientific activity of the staff

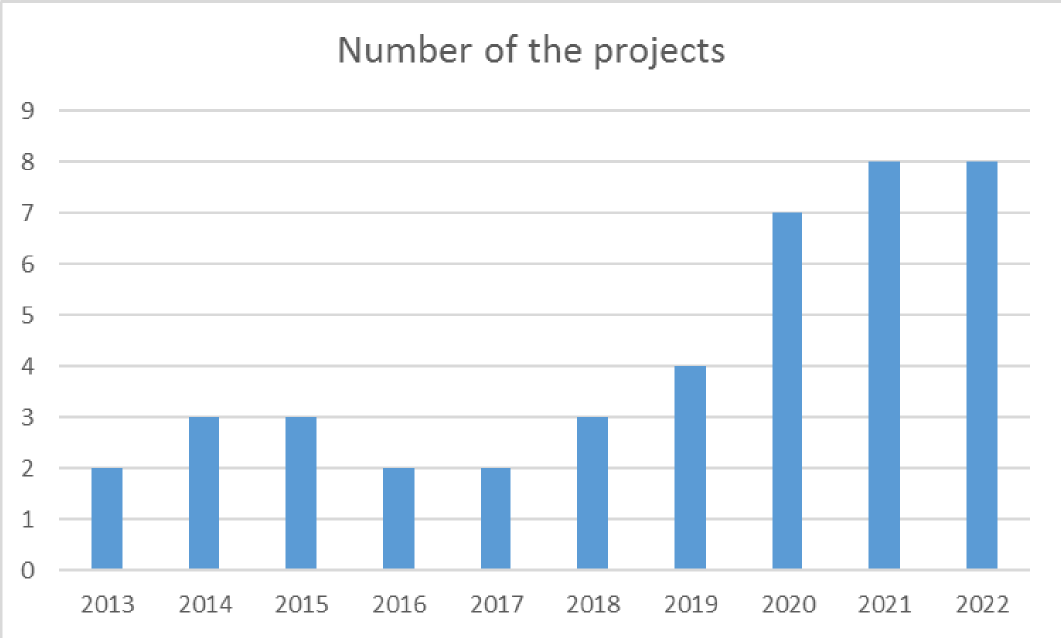
No	Personnel	Number of publications indexed by SCOPUS	Citation times	LCS expert entitlement	Industry

1.	Dmitrijs Pikuļins	31	87	17.04.2014 - 02.06.2024	Power engineering, electronics, information and communication technologies
2.	Anna Litviņenko	39	83	07.11.2018 - 02.02.2025	Power engineering, electronics, information and communication technologies
3.	Artūrs Aboltiņš	29	67	10.11.2014-05.04.2025	Power engineering, electronics, information and communication technologies
4.	Jānis Semeņako	12	16	21.01.2016 - 18.06.2020	Power engineering, electronics, information and communication technologies
5.	Arnis Gulbis	3	4	21.03.2013-21.03.2015	Physics
6.	Guntars Balodis	2	-	11.05.2010-11.05.2013	Electronics and telecommunications
7.	Elmārs Beķeris	2	4	-	
8.	Jānis Jankovskis	3	3	11.05.2010-11.05.2013	Electronics and telecommunications
Total		141	283		

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

At present, 5 teaching staff members are involved in providing the PhD Study Program courses. The staff was involved in 15 projects of various levels during the reporting period. The staff was involved in the listed projects as a supervisor or scientific supervisor in 12 projects, as a leading researcher or as the main contractor in 11 projects. A part of the projects is implemented in other European universities, like research of new MIMO multi-carrier modulation systems at Vismar Technical University, or in the industry, like the Measurements for satellite laser location with several impulse emission sources in the company Eventech. The staff was involved in the implementation of research projects with a total budget above 2, 500,000 EUR.

The summary of the involvement of the teaching staff in the supervision and implementation of research projects reveals a positive trend of more involvement of the staff, which is also confirmed by the split of implemented research projects per year. This trend can be explained by the change of the staff and active professional growth of newly involved Assoc. professors.



Summary of involvement of the academic staff in supervision and implementation of research projects						
No.	**Project title**	**Source of financing**	**Amount of financing**	**Duration**	**Personnel**	**Position**
1	Progressive wireless energy transmission methods	Fundamental and applied research project of the Latvian Council of Science (LCS)	299640 EUR	01.02.2022 - until now	Anna Litviņenko	Supervisor
					Dmitrijs Pikuļins	Leading researcher
2	Modulation of picosecond resolution impulse position for communications of unprecedented high energy efficiency	Fundamental and applied research project of the Latvian Council of Science (LCS)	299979 EUR	01.02.2022 - until now	Artūrs Āboltiņš	Supervisor
					Dmitrijs Pikuļins	Leading researcher
3	The new type of embedded robust chaotic oscillators for secure communication systems	ERDF	89,203 EUR	01.06.2021 - until now	Dmitrijs Pikuļins	Scientific supervisor

4	Multi-channel picosecond accuracy time tag system with range measurements for satellite laser location with several impulse emission sources	ERDF	383,007 EUR	01.01.2021- until now	Anna Litviņenko	Scientific supervisor
5	Solutions to the creation of narrowband wireless sensor networks	ERDF	133805 EUR	01.01.2019- until now	Dmitrijs Pikuļins	Scientific supervisor
					Artūrs Āboltiņš	Main contractor
					Anna Litviņenko	Main contractor
6	Development and testing of the new generation seal repelling devices	"Innovation" of the European Fund of Maritime and Fishery	161579 EUR	06.04.2020 - 31.03.2022	Dmitrijs Pikuļins	Scientific supervisor
7	National competence cents within the framework of EuroHPC	Horizon2020	600000 EUR	31.08.2020 - until now	Jānis Semeņako	Leading researcher
8	Radio Frequency Wireless Power Transfer for Wireless Sensor Network applications	Fundamental and applied research project of the Latvian Council of Science (LCS)	100389 EUR ,	01.12.2020-31.12.2021	Anna Litvinenko	Scientific supervisor

9	Development of the new cyberphysical infrastructure of water quality monitoring and fish-breeding management for improvement of productivity of aquaculture sites	"Innovation" of the European Fund of Maritime and Fishery	262186 EUR	01.05.2019-31.08.2021	Dmitrijs Pikuļins	Scientific supervisor
					Artūrs Āboltiņš	Leading researcher
10	Development of the hybrid intellectual acoustic-optic system for minimisation of the damage caused by not hunted and migrant birds in the Latvian aqua culture industry	"Innovation" of the European Fund of Maritime and Fishery	236013 EUR	01.04.2018-31.03.2020	Dmitrijs Pikuļins	Scientific supervisor
					Artūrs Āboltiņš	Leading researcher
11	Development of the high performance underwater acoustic trasmitter of extended functionality for reduction of damage caused by seals in the seashore fishing in Latvia	Measure "Innovation" of the European Fund of Maritime and Fishery	170423 EUR	01.01.2017-31.12.2018	Dmitrijs Pikuļins	Scientific supervisor
					Artūrs Āboltiņš	Leading researcher
12	Research of new MIMO multi-carrier modulation systems	Other	-	2015- until now	Artūrs Āboltiņš	Leading researcher
					Anna Litviņenko	Leading researcher

13	Complex solution of electromagnetic issues for signal electronics impulse feeding sources	Fundamental and applied research project of the Latvian Council of Science (LCS)	36187 LVL	2013-2016	Dmitrijs Pikuļins	Leading researcher
14	Effect of control non-idealities upon the non-linear dynamics of impulse-type transformers	RTU research project	-	2014-2015	Dmitrijs Pikuļins	Scientific supervisor
15	Research of the types of non-stabilities of impulse-type voltage transformers - full-scope bifurcation	RTU research project	-	2013-2014	Dmitrijs Pikuļins	Scientific supervisor

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

There is active cooperation of the teaching staff on various levels by using various cooperation models accordingly.

Study courses, teaching materials, the study program, development strategy and the sustainability plan are continuously updated, supplemented and improved. New study courses are developed or incorporated, taking into account development trends in the industry and the achievements of the scientific activity of the Institute of Radioelectronics. Improvement of cooperation is based on the scientific activity of the teaching staff, analysis of current trends, incorporation of changes in the RTU strategy, and following the industry development trends. The study process is being adopted at various levels of change: global, national, university, and Faculty. Amendments of the national laws related to the organisation of the study process, the RTU internal orders for providing the study process, changes in the development strategy of RTU and the Faculty, and the industry development trends on the national, European and global levels are followed. The students' opinion regarding the quality of the materials of study courses and teaching as presented during the study process is also considered.

Cooperation is implemented via direct channels of communication, like personal and remote meetings and workshops - for improvement of the development strategy and the sustainability plan, renovation of the study program, discussion and adjustment of study plans, analysis of the students' study progress, improvement and succession of study courses, creation of new courses, discussion of the topics of qualification projects, adaptation of the study process for various changes, discussion and coordination of strategic and major issues, presentation of the results of the teaching and scientific work.

Also, electronic means of communication are used: e-mail - for distribution of orders related to the study process at RTU, the announcement of various events and sharing of other topical information; social networks, like Facebook and Instagram - for the announcement of various events; messengers, like WhatsApp groups - for discussing essential and urgent matters, for sharing information.

Various tools of sharing and arranging documents - file-hosting sites - Onedrive, Googledocs, Microsoft Teams - for development of shared documents, materials, their storage and distribution; ORTUS - the uniform RTU system for sharing and storing of descriptions and materials of study courses, provision of the study process, distribution of results of scientific activity, storing and sharing of graduation projects, the announcement of news and events, surveys of students regarding the quality of provision of study courses - used for the provision of the study processes on a daily basis.

For sharing professional and science achievements, special social networks, like Researchgate, Linkedin, are used, and special databases, like Scopus and IEEExplorer, are used to share scientific activities.

17 students and 5 teaching staff members are currently involved in the study process. As a result of the active cooperation of the teaching staff, the provision and improvement of the program and the active involvement of students in the research work is implemented continuously and effectively.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	EDJ0_DoktorProgr_LV_ENG.pdf	EDJ0_DoktorProgr_LV_ENG.pdf
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_EDJ0(51523)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_EDJ0(51523)_AIP_atzinums250stud_Elektronika.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EDJ0(51523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EDJ0(51523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard		
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EDJ0(51523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EDJ0(51523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EDJ0(51523)_Plan_eng.zip	P09_3.2.1_EDJ0(51523)_Plans_lv.zip
Descriptions of the study courses/ modules	A10_EDJ0(51523)_StudyCoursesdescr_ENG.zip	P10_EDJ0(51523)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)	EDJ0(51523)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip	EDJ0(51523)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Telecommunication Technologies and Data Transmission Engineering (43526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Telecommunication Technologies and Data Transmission Engineering*
Education classification code	*43526*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Vjačeslavs*
Surname of the study programme director	*Bobrovs*
E-mail of the study programme director	*Vjaceslavs.Bobrovs@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*+37127896246*
Goal of the study programme	*The study program aims to provide students with the acquisition of theoretical knowledge and research skills in the field of engineering, which is based on theoretical principles in the fields of telecommunication technology and data transmission; to prepare innovative-minded specialists focused on the introduction of new technologies and knowledge with internationally competitive academic education. The aims and tasks of the study program are formulated based on surveys of the needs and requirements of stakeholders (potential employers, universities, students, society, and scientific institutions) to graduate.*

Tasks of the study programme	*1. To provide competitive education in the fields of telecommunication technologies and data transmission in accordance with the level of bachelor's studies and international standards;* *2. To provide the basics of fundamental sciences necessary for the acquisition of theoretical study courses in the field;* *3. To ensure the acquisition of specialized knowledge characteristic of the study program and the ability to apply it for the formulation and solution of tasks in telecommunication technology and data transmission engineering;* *4. To provide students with knowledge about the use of computer tools in the analysis, modeling, design, and programming of individual modules;* *5. To ensure the development and changes of the content of the study program, implementation of the study process, scientific research work, following changes in the field of telecommunication and data transmission, international practice, science;* *6. To provide students with comprehensive internationally competitive knowledge and develop competence following the market-defined requirements for telecommunications and communications engineers, preparing for practical work in the design, development, and maintenance of communications systems, large-scale data transmission, and processing;* *7. To develop students' skills to perform high-quality acquisition, selection, analysis of necessary information, use for decision-making, as well as solving problems in the telecommunication and data transmission sector;* *8. To promote students' interest in further supplementation of academic knowledge and further studies, to develop research skills, and to promote their practical use;* *9. To stimulate the interest of students in the processes taking place in society, to stimulate their development towards a positive, modern, responsible, ethical and capable personality able to act independently and make decisions;* *10. To promote international mobility and participation in projects.*

Results of the study programme	*1. Knows the basics of fundamental sciences necessary for the acquisition of theoretical study courses in the field; 2. Manages the content of basic study courses of the telecommunication and data transmission sub-sector at the level necessary for the acquisition of specialized study courses and innovations in the field; 3. Knows at the level of understanding: telecommunication and computer networks, main technologies and standards, principles of operation of telecommunication equipment, design methods of telecommunication networks and systems, data transmission systems and their main concepts, basics of operation of telecommunication equipment and networks and measurement methods; 4. Is able to work with scientific, technical, and methodological literature available in a foreign language; 5. Is able to use theoretical knowledge to formulate and solve specific tasks in the telecommunication and data transmission sub-sector; 6. Is able to perform experimental data processing in the analysis of the features of the operation of telecommunication and data transmission systems; 7. Able to develop applications and algorithms for solving specific tasks; 8. Able to systematize related information, summarize, interpret and analyze the results of measurements and calculations, prepare summarized reports, present them; 9. Is able to apply current technologies and software in the process of designing telecommunication and data transmission systems; 10. Is able to perform an analysis of the situation regarding current problems in telecommunications data transmission systems and their solutions, based on the study of literature and information available on the Internet; 11. Able to perform diagnostics of telecommunications networks and equipment, and evaluation of the main operating parameters; 12. Is able to work individually and in a team, to continue learning and educating in the field of telecommunications and data transmission systems, to act in a sustainable, ethical and responsible manner so as not to cause harm to society and the environment.*
Final examination upon the completion of the study programme	*The acquisition of the program concludes with a final exam, which includes the development of an independent bachelor's thesis and public defence in an open session.*

Study programme forms

Full time studies - 3 years - latvian

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*120*
Admission requirements (in English)	*General or vocational secondary education*

Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Telecommunication Engineering*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 3 years - english

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*english*
Amount (CP)	*120*
Admission requirements (in English)	*General Secondary or Vocational Secondary Education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Telecommunication Engineering*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The bachelor's academic study programme “Telecommunication Technologies and Data Transmission Engineering” has been implemented for more than 25 years. The programme is licensed on 03.04.2007. (licence No 04051-108).

The volume of the study programme is 120 credit points (CP) or 180 credit points according to the European Credit Transfer and Accumulation System (ECTS). The type of implementation is full-time intramural studies (3 years). The full-time study programmes are implemented in the standard planning of Riga Technical University (RTU) in each study year there are 2 semesters, length of each semester is 20 weeks - 16 study weeks and 4 session weeks. To start the studies general secondary education or professional secondary education is required. The study programme is implemented in Latvian and English languages.

In the reporting period, significant changes in the programme have been done in order to improve the study programme and to provide students in a more complete way with theoretical knowledge and the necessary basic skills for working in the profession.

There are following substantial changes to the study programme parameters since the issuance of the previous accreditation form of the study field:

1. new director of the study programme professor Vjačeslavs Bobrovs. V. Bobrovs has the corresponding qualification and experience in elaboration of the content of higher academic education study programme;
2. the volume of the study programme is decreased from 122 CP to 120 CP;
3. title of the academic studies is changed from “Telecommunication” to “Telecommunication Technologies and Data Transmission Engineering”;
4. the educational classification code of the study program was changed to 43526 – "Other engineering sciences";
5. the degree to be obtained has been changed to "Bachelor Degree of Engineering Science in Telecommunication Engineering";
6. the place of implementation of the study programme - Riga;
7. volume of the compulsory part (A) is decreased from 86 CP to 77 CP;
    - such courses were excluded from the compulsory part (A): RRE102 Electricity and Magnetism – 2CP, ĶVĶ109 General Chemistry – 2 CP, REA103 Fundamentals of Materials Science – 2 CP, RTR105 Computer Studies (basic course) – 3 CP, RTR108 Computer Studies (special course) – 2 CP, RTR207 Computerization of Mathematical Tasks in Electrical Engineering – 3 CP, RTR223 Electrical Engineering Theory – 6 CP, RTR215 Circuit Theory – 5 CP, RTR220 Basics of Signal Theory– 4 CP, REA204 Electron Devices – 3 CP, REA202 Electrical Measurements – 3 CP, RTC106 Commercial Operations (Distance Learning e-Course) – 2 KP, RAE361 Digital Devices of Telecommunications Systems – 3 CP, RDE301 Telecommunications Theory – 5 CP,

RDE303 Transmission Systems– 4 CP, RRI100 Introduction to Study Field – 6 CP, HFA101 Sport Activity – 1 CP.
   - such courses are included in the compulsory part (A): RDE710 Introduction to Electronics and Telecommunications Branch – 4 CP, SDD701 Innovative Product Development and Entrepreneurship – 4 CP, RDE708 Telecommunications Systems – 6 CP, RDE709 Electrical Measurements in Telecommunications – 4 CP, RAE701 Digital Devices of Telecommunications Systems – 4 CP, RDE707 Telecommunications Theory – 6 CP, RDE706 Transmission Systems – 6 CP, RAE202 Computer Technologies in Telecommunications – 3 CP, RAE348 Telecommunications and Computer Networks – 3 CP, VAS038 Environment and Climate Roadmap – 1 CP.

8. the volume of the compulsory elective part (B) in increased from 22 CP to 29 CP, the volume of the compulsory elective professional specialisation (B1) part – from 15 CP to 24 CP and the humanitarian and social (B2) part – from 4 CP to 2 CP;
   - the following study courses are excluded from the compulsory elective professional specialisation (B1) part: REA302 Materials, Components, Microelectronics – 3 CP, RRI349 Analogue and Digital Integrated Circuits – 3 CP, RAE202 Computer Technologies in Telecommunications – 3 CP, RAE305 Teletraffic Theory – 3 CP, RDE304 Electrical Measurements in Telecommunications – 3 CP, RAE348 Telecommunications and Computer Networks – 3 CP;
   - the following study courses are included into the compulsory elective professional specialisation (B1) part: RAE700 Teletraffic Theory – 4 CP, TRT215 Fundamentals of Circuit Theory – 3 CP, RRE102 Electricity and Magnetism – 2 CP, REA103 Fundamentals of Materials Science – 2 CP, REA204 Electron Devices – 3 CP, TRT203 Semiconductor Devices – 3 CP, TRT273 The Basics of Control Theory – 2 CP, TRT461 The C Programming Language – 2 CP, RDE705 Research Seminars in the Field of Telecommunications – 4 CP, RTR105 Computer Studies (basic course) – 3 CP, RTR207 Computerization of Mathematical Tasks in Electrical Engineering – 3 CP, TRT441 Computer Technologies in Research – 3 CP, TRL244 Computer Networks – 2 CP, TRT313 Real-Time Communication Systems (study project) – 2 CP, RTR107 Introduction to Computers and Algorithms – 2 CP, TRL415 Network Databases and Databanks – 3 CP, TRL326 Network Reliability – 3 CP, TRL534 Computer Network Monitoring, Diagnostics and Maintenance – 3 CP, RDE711 Mobile Network Architecture – 4 CP, RTR805 Fundamentals of DC Circuits – 2 CP, RTR806 Fundamentals of AC Circuits – 3 CP;
   - the following study course is excluded from the humanitarian and social (B2) part: HFL336 Basic Ethics – 2 CP.

The made changes are connected with improvement of the study process and the quality, taking into account the recommendations from enterprises and graduates of the field, as well as technology development tendencies in order to provide modern learning according to the requirements of the field.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The academic bachelor's study programme „Telecommunication Technologies and Data Transmission Engineering" is elaborated in accordance with the Law on Higher Education Institutions of the Republic of Latvia and in accordance with the Classification of Education of the Republic of Latvia.

For implementation and development of the study programme over the course of time, principles of Latvian classification infrastructure (LKI) and European classification infrastructure (EKI) are observed.

The study programme is developed taking into account RTU strategic objectives, market offers and potential demands.

The study programme is elaborated according to the RTU strategy and the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science". Acquisition of the skills and knowledge anticipated in the study programme is provided by the academic and scientific staff at the European level. During the implementation of the study programme, innovative study methods are used - the use of more practical and modern technologies.

The study program is included in the study direction "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which is characterized by a set of study programs whose main focus is on the use of technologies and scientific knowledge specific to the direction in the study process.

The study program directly corresponds to the study filed "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", because the content of the study program focuses on telecommunications engineering and includes knowledge and skills that correspond to information technologies, electronics, telecommunications and partially also computer science.

In recent years, a series of technological solutions for ensuring communications have appeared in the world. Currently, the most common technologies are low-frequency and high-frequency wireless solutions, as well as closed and open optical communication systems. Therefore, the concretization of the name of the study program „Telecommunication Technologies and Data Transmission Engineering", where we reflect the modern word "technology", and also define what the graduates of the study program will deal with - create technologically complex communication solutions, and that is "data transmission engineering".

The classification code of the study program 43526 – "Other engineering sciences" has been chosen because the name, purpose, content and awarded the degree of the program are related to telecommunications technology and data transmission engineering, which includes complex electrical communication technological solutions, which by their nature correspond to engineering sciences. Graduates of the program are awarded the "Bachelor Degree of Engineering Science in Telecommunication Engineering".

The full scope of the study program is 120 CP and the duration of implementation is 3 years. The duration and scope of the program implementation allow for covering the skills and knowledge defined in the study program.

The objective of the study programme is to provide acquisition of theoretical and research skills in the field of engineering for the students, based on theoretical statements in the fields of telecommunication technologies and data transmission; to prepare specialists with academic education, innovative thinking, who are oriented to the introduction of new technologies and knowledge, as well as to provide knowledge, skills and competences according to the level 6 of the qualification infrastructure of Latvia. Objectives and tasks of the study programme are formulated on the basis of surveys about the wishes and demands of the interested parties (potential employers, universities, students, society and scientific institutions) to the graduate.

The strategical objective within the framework of the existing RTU strategy is to provide internationally competitive higher-quality scientific research, higher education, and technology transmission in the field of telecommunications by formulating strategical tasks of the faculty - qualitative study process, excellent research, sustainable commercialisation/valorization.

Tasks of the study programme:

- To provide competitive education in the fields of telecommunication technologies and data transmission in accordance with the level of bachelor's studies and international standards;
- To provide the basics of fundamental sciences necessary for the acquisition of theoretical study courses in the field;
- To ensure the acquisition of specialized knowledge characteristic of the study program and the ability to apply it for the formulation and solution of tasks in telecommunication technology and data transmission engineering;
- To provide students with knowledge about the use of computer tools in the analysis, modeling, design, and programming of individual modules;
- To ensure the development and changes of the content of the study program, implementation of the study process, scientific research work, following changes in the field of telecommunication and data transmission, international practice, science;
- To provide students with comprehensive internationally competitive knowledge and develop competence following the market-defined requirements for telecommunications and communications engineers, preparing for practical work in the design, development, and maintenance of communications systems, large-scale data transmission, and processing;
- To develop students' skills to perform high-quality acquisition, selection, analysis of necessary information, use for decision-making, as well as solving problems in the telecommunication and data transmission sector;
- To promote students' interest in further supplementation of academic knowledge and further studies, to develop research skills, and to promote their practical use;
- To stimulate the interest of students in the processes taking place in society, to stimulate their development towards a positive, modern, responsible, ethical and capable personality able to act independently and make decisions;
- To promote international mobility and participation in projects.

After the acquisition of the study programme the graduate (**planned achievable results**):

- Knows the basics of fundamental sciences necessary for the acquisition of theoretical study courses in the field;
- Manages the content of basic study courses of the telecommunication and data transmission subsector at the level necessary for the acquisition of specialized study courses and innovations in the field;
- Knows at the level of understanding: telecommunication and computer networks, main technologies and standards, principles of operation of telecommunication equipment, design methods of telecommunication networks and systems, data transmission systems and their main concepts, basics of operation of telecommunication equipment and networks and measurement methods;
- Is able to work with scientific, technical, and methodological literature available in a foreign

language;
- Is able to use theoretical knowledge to formulate and solve specific tasks in the telecommunication and data transmission subsector;
- Is able to perform experimental data processing in the analysis of the features of the operation of telecommunication and data transmission systems;
- Able to develop applications and algorithms for solving specific tasks;
- Able to systematize related information, summarize, interpret and analyze the results of measurements and calculations, prepare summarized reports, present them;
- Is able to apply current technologies and software in the process of designing telecommunication and data transmission systems;
- Is able to perform an analysis of the situation regarding current problems in telecommunications data transmission systems and their solutions, based on the study of literature and information available on the Internet;
- Able to perform diagnostics of telecommunications networks and equipment, and evaluation of the main operating parameters;
- Is able to work individually and in a team, to continue learning and educating in the field of telecommunications and data transmission systems, and to act in a sustainable, ethical and responsible manner so as not to cause harm to society and the environment.

Measurements of the study programme results are reflected in study results of students, employment of the graduates, feedback from employers, enhancement of international cooperation, increase of the number of projects, increase of the number of students involved in the research process, the approbation of the research results.

The title of the study programme, the obtained degree, objectives, tasks and achievable results are mutually linked and the reach thereof is very high.

Candidates with general or professional secondary education can enrol on the programme. Enrolment of candidates for full-time basic studies in the study programme is done according to the results in the centralised examinations (CE) in Mathematics, Latvian and foreign languages.

Graduates of the study programme obtain an engineering science bachelor’s degree in Telecommunication Engineering.

After the acquisition of the degree, there are opportunities to continue education in master’s academic or professional study programmes.

The programme with its activity promotes the keynote defined in the RTU Strategy for years 2021 – 2025: ”High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities in the Baltic and Nordic region, which is acting based on a study system built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies” and implements it in real life.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The field of telecommunications in Latvia and the world in the last years develops in a stable way, and the quality of the electrical communication infrastructure is at a very high level. Indicators of the field do increase and in the future synergy of the field of telecommunications with economics and other national economy, fields will be important. The economic and/or social justification of the study programme is based on the research performed in the field and the employment of the graduates.

Employment of the graduates is an important indicator, which shows the need for specialists prepared in the study programme in the labour market. Employment of the graduates of the study programme “Telecommunication Technologies and Data Transmission Engineering” is high and the surveyed graduates make their career in the profession obtained. Most graduates work in telecommunication enterprises, IT companies, higher schools, scientific research institutions, and industrial fields in Latvia and abroad. A large part of employers proposes work offers already during studies. In the period from the study year 2013/2014 until the study year 2021/2022, about 80% of the graduates worked in parallel with their studies. Graduates of the study programme can become consultants, designers, technicians, engineers, infrastructure specialists, telecommunication system analysis and supervision specialists, and telecommunication solution elaboration and introduction specialists. The knowledge obtained during the studies allows graduates to take leading positions in teams of private enterprises or governmental institutions, as well as lead projects in the field of the latest technologies.

Surveys of graduates provide recommendations for improvement of the study programme:

- Study course rotation by semesters;
- To increase the number of guest lecturers for implementation of the study courses, who work in the enterprises of the field;
- Inclusion of new study courses into the study programme.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The academic bachelor's study programme “Telecommunication Technologies and Data Transmission Engineering” is a full-time study programme, which can be acquired in Latvian and English. In the review period, the total number of students in the programme has changed from 321 students in the academic year 2013/2014 to 164 students in the academic year 2021/2022. Within the last two study years in comparison to the academic year 2013/2014, the number of students receiving state support decreased by 50%. Oscillations in the number of students are connected to the results of central examinations of school graduates (especially in exact subjects), social and economic situation in the state (employment, migration, demography), development trends in the telecommunication field in Latvia and abroad.

Table 1: Dynamics of the number of students in the academic bachelor’s study programme “Telecommunication Technologies and Data Transmission Engineering”

Study year	Academic bachelor study programme “Telecommunication Technologies and Data Transmission Engineering”							
	Enrolled in the 1st year		Study in the programme			Exmatriculated		
	State	Tuition fee	State	Tuition fee	Active foreign students	With diploma	Academic failure	Due to other reasons
2013/2014	190	14	309	12	28	75	96	40
2014/2015	154	10	262	18	26	48	97	25
2015/2016	160	10	242	18	28	50	73	19
2016/2017	136	5	234	11	30	34	89	8
2017/2018	151	6	249	13	17	23	53	29
2018/2019	128	10	242	11	15	41	62	23
2019/2020	75	7	217	12	17	24	47	21
2020/2021	82	15	169	25	20	46	30	20
2021/2022*	7	13	140	24	22	3	61	30
Average per year	**120**	**10**	**230**	**16**	**23**	**39**	**67**	**23**

* Data until 15.02.2022

Within the period from the academic year 2013/2014 until the academic year 2021/2022, the study programme has graduated 344 applicants. Each year on average 39 students finish the study programme with a diploma.

Comparatively large is the number of students exmatriculated for academic failure - these are on average 67 students per year. In its turn, on average 23 students are exmatriculated and do not finish their studies due to various reasons - employment load family reasons etc. The larger drop-out number of students is observed in the first and second study year, and the most frequent reason is academic failure. This indicates that students did not have the necessary level of knowledge in order to acquire courses in Mathematics and Physics. A lot fewer students are exmatriculated voluntarily. Usually, this happens due to health conditions or family conditions. There could be rare cases when students do not return from academic leave.

Since 2013/2014 the number of foreign students has increased and on average 23 foreign students, who are very positive and show that the programme is important also abroad. As to the analysis of foreign students, it is necessary to mention that all of them are full-time students and are paying the tuition fee.

The number of students using the mobility programmes, in this case, is 15 students per year on average.

Foreign students are mostly from Asian countries, the wide popularity of the study programme was achieved thanks to the active involvement of the Foreign Student Department and the director of the study programme, participation in international conferences and actively promoting recognizability of the study programme.

Statistical data on the academic bachelor’s study programme “Telecommunication Technologies and Data Transmission Engineering” are summarized in Appendix P05_3.1.4_EGB0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The bachelor level study programme “Telecommunication Technologies and Data Transmission Engineering” is created according to the requirements of the labour market and the newest scientific tendencies. The study programme has been implemented for more than 25 years and has not lost its significance and importance, it is continuously developing. The programme has been accredited several times, the last accreditation was in 2013 (Accreditation page No 2020/38) and the accreditation expiration date is 31st of December, 2023.

The place of implementation of the study programme is Riga. The type of implementation is full-time intramural studies (3 years). In the standard planning of RTU in each study year, there are 2 semesters, the length of each semester is 20 weeks - 16 study weeks and 4 session weeks.

The content of the study programme is updated according to the tendencies of the field, labour market and science development. Each year the study programme is improved, taking into account results of student surveys as well as recommendations from the employers and the graduates. The vision of the bachelor’s academic study programme “Telecommunication Technologies and Data Transmission Engineering” is implemented on the basis of the opinion of students, graduates, employers, and professional and non-government organisations, observing the direction stated in the development plans of Latvia and according to RTU mission and vision, objectives and tasks.

The competitiveness of the study programme is confirmed by the fact that all graduates are required in the labour market and are employed in their speciality just after graduation of studies.

The information included in the study courses is subordinate to the objective of the study programme - to provide students with basic knowledge and skills. In the study programme, a connection is provided between the information included in the study courses, the achieved results, defined objectives, and methods as well as a connection to each study course with the objectives and achievable results of the study programme. The objective of the programme has been developed according to the needs of the national economy and society. The tasks of the programme are created in such a way to educate students in accordance with the Latvian qualification infrastructure level, as well as to promote the competitiveness of students in changeable social-economic conditions and in the international labour market.

The study programme is implemented in the form of lectures and practical classes, reserving significant time for independent studies. The content of the study programme corresponds to the requirements of the normative acts, and is created by observing RTU Senate decision conditions "About common requirements for study programmes".

The duration of the studies is 3 years, which are split into 6 study semesters, during which compulsory study courses, specialisation and free option study courses are acquired. At the end of studies, a bachelor thesis shall be elaborated.

There are several study courses choosing and acquiring principles in the study programme. Those study courses with the objective to provide the necessary minimal knowledge, skills and abilities in the field of telecommunications are included in the compulsory part and are acquired by all the students in full volume. Those study courses, which enhance knowledge and understanding or offer deeper acquisition of specific skills and abilities are included in the compulsory choice part and students have to choose them within the framework of limits determined by the study programme.

The anticipated volume of compulsory study courses of the study programme is 77 CP (115.5 ECTS). The compulsory courses of the study programme develop students' knowledge and skills in the fields of telecommunication technologies and data transmission engineering as well as improve knowledge and skills about scientific research methods and the application thereof. The compulsory elective (specialisation) study courses of the study direction (24 CP or 36 ECTS) are anticipated for potential students to be able to deeper their knowledge in the chosen specialisation field. There are also humanitarian and social study courses included in the study programme (2 CP or 3 ECTS), language study courses (3 CP or 4,5 ECTS), as well as free option study courses (4 CP or 6 ECTS). The programme acquisition is finished with a bachelor's paper (10 CP or 15 ECTS).

Students of the programme branch in English may choose the Latvian language, and study course "Latvian language for foreign students" in the volume of 1 CP (VLS711).

Table 2: The study courses included in the study programme

No	Code	Name	Credit points
A		**Compulsory Study Courses**	**77.0**
1	DMF101	Mathematics	9.0
2	MFA101	Physics	6.0

3	DIM205	Supplementary Mathematics (for electrical engineering)	2.0
4	DMS212	Probability Theory and Mathematical Statistics	2.0
5	SDD701	Innovative Product Development and Entrepreneurship	4.0
6	RDE710	Introduction to Electronics and Telecommunications Branch	4.0
7	ICA301	Civil Defence	1.0
8	RAE261	Digital Electronics and Computer Architecture	3.0
9	RAE362	Digital Devices and Systems	3.0
10	RDE709	Electrical Measurements in Telecommunications	4.0
11	RDE708	Telecommunications Systems	6.0
12	RAE701	Digital Devices of Telecommunications Systems	4.0
13	RDE707	Telecommunications Theory	6.0
14	RDE706	Transmission Systems	6.0
15	RAE306	Digital Switching Systems	4.0
16	RDE302	Transmission Media	6.0
17	RAE202	Computer Technologies in Telecommunications	3.0
18	RAE348	Telecommunications and Computer Networks	3.0
19	VAS038	Environment and Climate Roadmap	1.0
B		**Compulsory Elective Study Courses**	**29.0**
B.1		**Study courses on the current achievements in the field**	**24.0**
1	RAE700	Teletraffic Theory	4.0
2	RAE359	Distributed Systems in Telecommunications	3.0
3	TRT215	Fundamentals of Circuit Theory	3.0
4	RRE102	Electricity and Magnetism	2.0
5	REA103	Fundamentals of Materials Science	2.0
6	REA204	Electron Devices	3.0
7	TRT203	Semiconductor Devices	3.0

8	TRT273	The Basics of Control Theory	2.0
9	TRT461	The C Programming Language	2.0
10	RDE705	Research Seminars in the Field of Telecommunications	4.0
11	RTR105	Computer Studies (basic course)	3.0
12	RTR207	Computerization of Mathematical Tasks in Electrical Engineering	3.0
13	TRT441	Computer Technologies in Research	3.0
14	TRL244	Computer Networks	2.0
15	TRT313	Real-Time Communication Systems (study project)	2.0
16	RTR107	Introduction to Computers and Algorithms	2.0
17	TRL415	Network Databases and Databanks	3.0
18	TRL326	Network Reliability	3.0
19	TRL534	Computer Network Monitoring, Diagnostics and Maintenance	3.0
20	RDE711	Mobile Network Architecture	4.0
21	RTR805	Fundamentals of DC Circuits	2.0
22	RTR806	Fundamentals of AC Circuits	3.0
B.2		**Humanities and Social Sciences Study Courses**	**2.0**
1	HSP380	United Europe and Latvia	2.0
2	HSP379	Political System of Latvia	2.0
3	HSP376	Sociology of Personalities and Small Groups	2.0
4	HSP375	Sociology of Management	2.0
5	HSP377	General Sociology	2.0
6	HPS120	Basics of Communication	2.0
B6		**Languages**	**3.0**
1	HVD101	The English Language	2.0
2	HVD230	The English Language	1.0
3	HVD108	The German Language	2.0

4	HVD226	The German Language	1.0
5	HVD119	The French Language	2.0
C		**Free Elective Study Courses**	**4.0**
E		**Final Examination**	**10.0**
1	RDE001	Bachelor Thesis	10.0

Lecture courses are generally theoretical, where research elements are embedded for students in the form of theses, research and other independent works. The orientation of practical classes is individual, where within the common topic each student elaborates on an individual study project. Acquisition of knowledge, skills and competencies in special subjects is monitored in the form of individual consultations. Attendance of practical classes is compulsory for all students during the whole period of studies.

During the study period of each study course, students have to pass the planned tests, and elaborate individual homework and study papers. Taking examinations is allowed only for those students, who have fulfilled all the requirements anticipated in the programme of the study course. Results of examinations and tests are fixed in the RTU study management electronic database.

During the time of elaboration of the bachelor thesis reviews for bachelor thesis elaboration progress are organized, where students present their progress of the research to the responsible teaching staff.

Study courses are improved and appended if the teaching staff responsible for the course thinks it is necessary.

At the same time, it is necessary to underline that all teaching staff involved in the implementation of the study programme perform research work, which is reflected in CVs, publications and participation in the projects.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

Not applicable.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study

process.

The study programme is implemented by joining theoretical and practical knowledge and skills in the form of lectures, seminars and practical activities. In the study programme, the study courses and elaboration of the graduation paper are proportionally distributed by semesters so that they append each other by providing students acquisition of the targeted knowledge and skills. In general, the study programme and each semester plan are created by focusing on the acquisition and strengthening of theoretical and professional skills of each student by working individually or in a team.

Assessment of study results takes place according to the Regulation for assessment of learning outcomes and the Regulation for final examinations at Riga Technical University.

The teaching staff responsible for the study courses, according to course content and programme specification, as well as student needs, choose the structuring, teaching and evaluation methods of the study courses. There are courses and seminars organized for the academic staff about the newest pedagogical methods, as well as attendance to qualification raising and upgrading courses is promoted within the Faculty, RTU and worldwide. RTU academic excellence centre organizes academic staff training events at the university level.

The study program is implemented in Latvian and English and provides for full-time studies. When implementing the content of the program, the requirements formulated in regulatory acts and the basic principles of study process organization determined by RTU are taken into account, as well as all study course requirements are met. The course descriptions of the study program define a set of relevant knowledge, skills and competencies and their evaluation system. The intended study results are defined, for the achievement of which credit points are awarded. The full-time type of study corresponds to 40 CP in the academic year. In bachelor's studies, 50% of the workload is contact hours and 50% is independent work.

In providing the content of the study program (Latvian and English languages), the pedagogical methods are chosen by the teaching staff responsible for the study course, according to the specifics of the study program and the needs of the students. The study process is organized in the form of lectures, laboratory work and practical work so that students acquire both theoretical and practical knowledge. Various study methods are used in it: lectures, seminars, presentations, group works, discussions, situation analysis, solving practical tasks to strengthen knowledge and control tests - to test knowledge. In order to inform students about the latest trends in the industry, guest lectures by industry experts and company representatives are held regularly.

The methods used in the study programme promote the acquisition of objectives and results of the study courses and the programme. To the improvement of the study process students can express their wishes to the teaching staff of the certain study course, the head of the group, the programme director or with the help of student self-government, representatives of which are members of the Council of the Faculty of Electronics and Telecommunications (FET), RTU Senate and RTU Senate commission as well as members of RTU Academic council. FET make relationships with students on the basis of principles of mutual trust, respect and integrity. Students are provided with an opportunity to influence their own process of studies, implement their own autonomy, and submit feedback on the process of studies by combining it with their own professional growth interests. A large role in the provision of linkage among students, teaching staff and programme administration is given to the FET student self-government, which actively takes part in all the mentioned processes and performs an annual assessment of the teaching staff.

When starting the study course, the teaching staff inform students about the requirements for the acquisition of the study course and introduces to students the assessment criteria of the study course. All information is published in the electronic environment of study courses ORTUS. Once per semester students assess the work of the teaching staff in the ORTUS environment by answering a questionnaire. This includes assessment of the advancement of studies, individual tasks, acquired skills, relationships and cooperation of a teacher with students. Questionnaires are anonymous.

In the study programme, complete implementation of study results is provided. The study results are formulated both at the study programme level and at the study course level. The achievable learning outcomes are discussed with students at the beginning of each study course, and also such information is available in the ORTUS environment. A linkage is provided between the achievable results of the study programme and those of the study courses. According to the achievable results of the study programme, content and volume in credit points of study courses are created, and in its turn, according to the achievable results of the study course, topics and volume thereof are created. In all study courses, the achievable results are verified with the corresponding assessment methods.

During the implementation process, the study programme is appended and updated on the basis of science development, labour market research and consultations with employers and practising experts. Recommendations received from graduates, students and teaching staff of the university are significant for the improvement of the study process.

Many various study methods are used in the pedagogical process: individual and group work, individual and group consultations, presentation of results, project work, tests, verbal and written examinations, practical laboratory works, discussions etc.

A significant role is given to the independent learning of students. Description of independent work is included in the description of the study course as a compulsory component. The ability of students to learn independently is purposefully developed in all study courses. Students acquire practical and research work skills by regular use of literature and Internet resources, including international scientific databases, which are available at RTU library with electronic access to the ORTUS environment, in order to successfully elaborate research study papers.

The centre of RTU structural units, including staff, science, international relations, studies and also Academic excellence regularly inform the staff about opportunities to improve their competencies in scientific research and methodological and digital skills in the field of general competencies and specific professional activity. In the ORTUS environment information about the scientific activity of the academic staff is stored. To perform pedagogical work at a high level, methodological seminars are organised for RTU teaching staff about opportunities for the application of various learning methods, experiences and best practices.

Academic staff of the programme regularly improve the content of studies by introducing to the study process new, innovative study organisation and learning methods, the main objective is to teach how to learn, look for information, use various sources of information, discuss, work together with others, make decisions and take responsibility. Cooperation here is done in both directions, student-student and teacher-student. International experience is integrated into the study process.

During the studies, the student-centered approach is adopted. In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific undergraduate paper research, and the choice of a particular major, as well as in group work, which to a large extent also allows the manifestation of organizational skills, leadership qualities and other transdisciplinary skills.

In order to enable effective use of the study materials for practical and independent work, RTU uses the ORTUS e-learning environment, and additional communication opportunities provided by this system as well.

Analyzing the study implementation and results in evaluation methods used in the study program, it must be concluded that the principles of student-centered education are consistently observed:

- the student contingent and the diversity of their needs are taken into account and respected when creating suitable learning paths;
- different ways of implementing the study program have been used;
- guided by the student’s abilities and needs, the teaching staff uses diverse pedagogical methods and encourages the student's desire for independence, while at the same time providing the teacher's guidance and support;
- the conduct of the study process in the study program promotes mutual respect in the relationship between students and teaching staff, as the principle of democracy is observed and the administration of the study program takes into account the opinion of students.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Not applicable.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

At the end of the programme, students have to elaborate a bachelor thesis (10 CP or 15 ECTS), which is devoted to actual problems in the fields of telecommunication technologies and data transmission engineering. The bachelor's paper is defended in public before the Final examination commission. The commission acts according to the regulations approved by the Senate of the university “About approval of a new edition of the regulation on study final examinations in Riga Technical University ”.

The topics of students’ graduation papers are chosen according to the most relevant topics in the field in Latvia and in the world. In the case of bachelor theses, each student has a possibility to choose a research field and topic of the graduation paper independently according to own interests, consulting with the teaching staff, as well as choose one of the topics offered by RTU ETF Institute of Telecommunication, which are also based on research topics of Institute of Telecommunications scientific projects. The objective of the bachelor thesis is to approve students’ ability to perform scientific research work in the field of telecommunications and the ability to use analytical, mathematical, optimisation and modelling methods for the solution of problems in the corresponding telecommunication subfield, based on the performed scientific literature review.

Students acquire abilities to perform research work by regularly working with literature and internet resources, which allow for the successful elaboration of a bachelor thesis. Students can present their research works at student conferences. For example, in 2017 at the RTU student conference, 9 students took part, in 2019 – 12 students, in 2020 – 7 students, and in 2021 – 7 students.

Below are examples of graduation paper topics that are given for the bachelor’s study programme “Telecommunication Technologies and Data Transmission Engineering”.

The study year 2013/2014

- Investigation of MPLS virtual private networks
- Power Startup Sequences of Computer Systemboard
- Research of Dismountable Optical Fiber Connectors
- Computation of photodiode parameters used in optical communication systems
- Impact of Macrobendings on Loss in Optical Fibers
- Impact of polarization to hologram samples in amorphous semiconductors
- Research of Bit Error Rate Evaluation Methods for Digitally Modulated Signals
- Use of K frequency range for creation of a microwave communication system
- Application of Shannon-Hartley Theorem in Transmission System with Coloured Noise
- Analysis of routing processes in IP networks
- Analysis of application of Mikrotik type routers in the laboratory
- Assessment of telephone channel characteristics
- Statistical Analysis of Speech Signal
- Research of GSM 900/1800 Bases Station Location
- Routing processes in wireless networks

The study year 2014/2015

- Research and Application of Optical Splitters in FOTS
- Mobile Application Use for the Internet Service Quality Assessment
- Research of Mechanical Dismountable Optical Fiber Connectors
- Analysis of LAN Packet Switching
- Video signal compression and image quality
- Assessment of Singlemode and Multimode Optical Fiber Splitters
- Base Station Received Signal Level Influence on its Performance in WCDMA Network
- Microwave Antenna Parameter Analysis in Ka Frequency Range
- OpenFlow Analysis with Mininet Network Emulation Tool
- Wireless Network IEEE 802.11 Standards Practical Analysis

- Opportunities of Network Technology Application at Enterprises

The study year 2015/2016

- Analog-to-digital Converter Operational Research
- Data Transmission Analysis in Low Voltage Networks
- Research and Application of Optical Splitters in FOTS
- Smart Remote Control System Design and Analysis
- Analysis of Welding Process in Singlemode Optical Fiber
- Evaluation of Optical Splitters Losses in FOTS
- Assessment of Service Quality for Voice Telephony in IP Networks
- The Virtual Routing Application Assessment
- Total Transition Attenuation Analysis of Local Computer Network Cables
- Assessment of Voice Transmission Quality Indicators in Mobile Networks
- Solving Telecommunication Traffic Problems with Petri Nets
- GSM Base Station the Main Parameters Evaluation and Analysis
- Assessment of compatibility opportunities of IPv4 and IPv6
- Evaluation of Microwave Communication System Parameters in the Ka Range

The study year 2016/2017

- LTE Radio Coverage Parameters Evaluation
- Assessment of Service Quality Parameters for Voice Transmission Applications in the IP environment
- Assessment of Measurement Precision of Internal Cable Parameters of Various Categories
- Comparison of Routing and Network Bridge Operation in the Main Networks of Service Providers
- Assessment of Optical Fiber Types Used in FOTS
- Evaluation of Macrobending Loss against Bending Radius in Optical Fibers
- Electromagnetic Compatibility Assessment of LTE TDD and Wi-Fi in the 2,3-2,4 GHz Range
- Evaluation of Microwave Communication System Configuration Parameters in the 24 GHz Range
- Research of Data Application Service Quality Evaluation Methods
- Analysis and Comparison of Shielded and Unshielded Twisted Pair Cable Parameters
- Research of Splicing Process in Different Types of Optical Fibers
- Analysis of Losses Introduced by Singlemode and Multimode Optical Fiber Splitters

The study year 2017/2018

- Research and Application of Optical Splitters in FOTS
- Analysis and Evaluation of Insertion Loss in Fiber Optical Connections
- Blocking Unmanned Airplane Control Signals Using Noise Generator
- Research and Evaluation of Optical Fiber Characteristics
- Use of Electronic Equalization in Transmission Systems
- Quality of Wi-Fi Service
- Internet Access Service Quality Evaluation Methods Research
- Analysis of BER Estimation Methods in Transmission Systems
- Investigation of the SIP Protocol Operating Principle in VoIP Technology Inside the Android Operating System Environment
- Analysis of Wireless Sensor Networks Routing Layer Protocols
- 4G Network Throughput Evaluation in Dynamic Mode
- Data Flow Analysis and Measuring Methods Comparison Internet Service Provision
- Data Traffic Analysis on Experimental Scheme with Mikrotik Routers

The study year 2018/2019

- Evaluation of Fiber Optical Transmission Line Attenuation with OTDR
- Optical Fiber Mechanical Connector Research and Comparison
- Research and Assessment of Sensor Networks for Smart Home Solutions
- Analysis of IEEE 802.11 protocol security solutions
- Technology Development Models and Application Thereof in Telecommunications
- Development and Evaluation of Permanent Fiber Optical Connections
- WiFi Network Service Quality Evaluation
- Remote Monitoring of the Most Important Devices of Electrical Energy Consumption Using Smart Counter Telecommunication Technologies
- Analysis of Mobile Communication base Station Load at Ķīpsala
- Assessment of CO2 Sensors for Indoor Air Quality Monitoring
- Development of Telecommunication System for Carnikava Culture House
- Migration to Next Generation Network Problem Analysis

The study year 2019/2020

- Research and development of a building management system using the ECY-S1000 controller
- Private Network Connection to Public Electronic Communication Networks and its Regulatory Aspects
- Evaluation and Comparison of Optical Fiber Dismountable Connectors
- Evaluation of wavelength division multiplexing system performance
- Speech Signal Research
- Research and Evaluation of the IoT`s Multi-layer Framework Thread Protocol
- Research and Evaluation of Optical Fiber Bragg Grating Sensors for Structural Health Monitoring
- Automatization solutions for dwelling buildings
- Research and Analysis of 5G FR2 Wave Propagation in Urban Open Space
- Investigation of 6LoWPAN Protocol Operating Principles Depending on Transmission Data Rate and Packet Size
- Research and Evaluation of Sensors Used in Aviation
- Development of Control Algorithms for Smart Homes Application
- Analysis and Comparison of Optical Connector Tip Surface Images
- Assessment of 5G Network Performance in Communication among Moving Object
- Research and Application of High-Speed up to 40 Gbit/s Optical Fiber Transmission Systems

The study year 2020/2021

- Analysis of vulnerabilities of routing protocols and their solutions
- Evaluation of transmissivity capacity of the tapered optical fiber
- Evaluation of Single Mode Optical Fiber Parameters
- Evaluation of the FBG temperature sensor operating principle
- Assessment of LoRaWAN and blockchain technology integration in urban environment
- Research of software use in sensor data transmission
- Evaluation and Research of Fiber Optical Sensor Types
- The investigation of communication among IoT devices in LoRaWAN network
- Investigation of High-Speed WDM Optical Transmission Systems
- Development and evaluation of sensor network for IoT solutions in urban environment
- Evaluation of 5G antenna depending on the location of the antenna in a moving object
- Investigation of 5G network base station radio coverage parameters
- Quality indicators for Internet service in 5G networks: European strategy and plans

- Electromagnetic Compatibility in 5G Mobile Network
- Research of problems and regulation of IPv6 implementation
- Evaluation of Types and Parameters of Light Sources Used in Fiber-Optical Communications Systems

In the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" the results of students' final examinations are discussed one time per year at RTU FET Institute of Telecommunications meetings. The results are summarized and evaluated also by the programme administrators and are used as a basis for further improvement of the study process.

In the review period from 2013/2014 until 2020/2021 study years, the average evaluation of the graduation bachelor theses on the 10-point scale was 8,22.

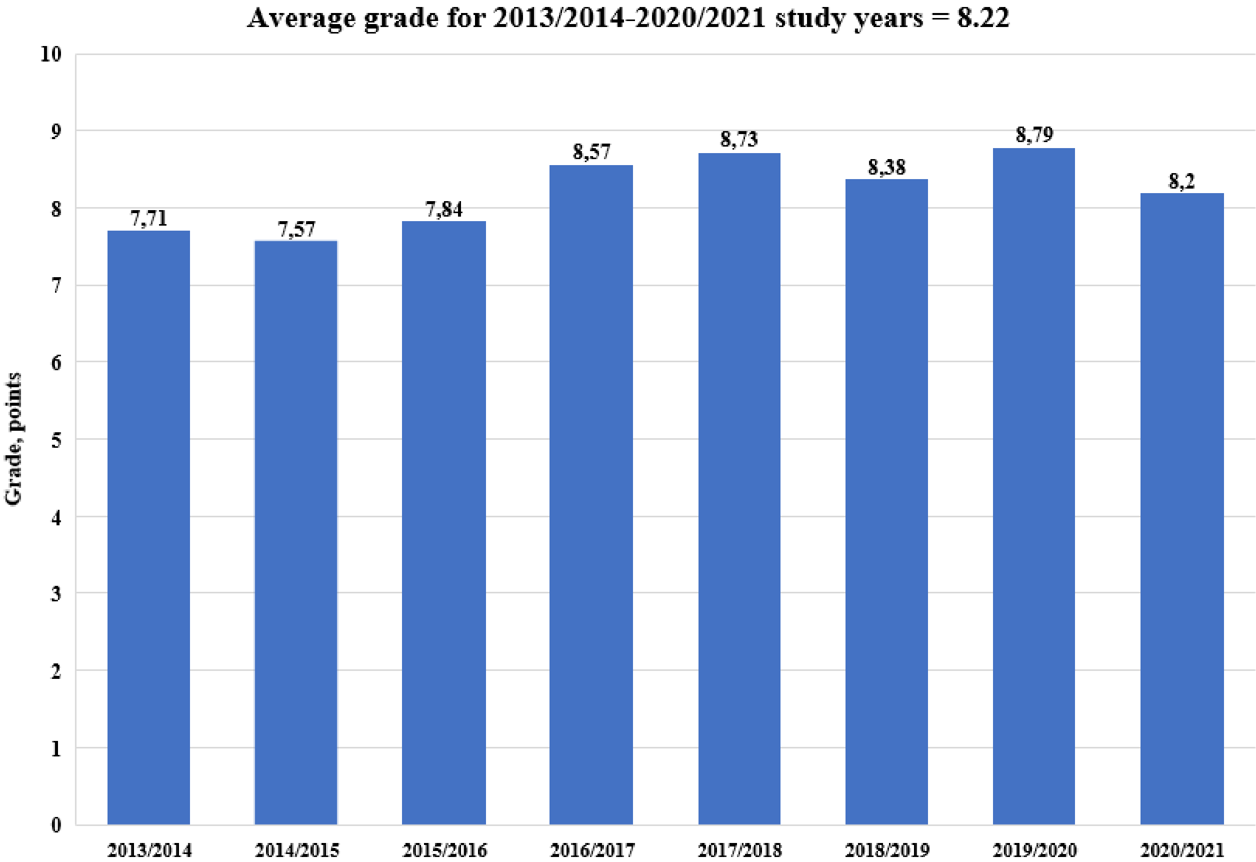


Figure 1: Average evaluations of graduation papers within the review period in the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering".

The final examination commission of RTU FET Institute of Telecommunications evaluates the participation of students in scientific and research activities (conferences, publications), assigning higher marks for this.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the

respective examples.

RTU have the decentralized budget, therefore each structural unit has a separate budget. The budget generally means a plan of incomes and expenses for a certain time period, work, event or a function. RTU incomes and expenses are administrated by the principles approved by the Senate or by the vice-rector for finances with assigned powers. Income can be of such categories, which are allocated to a structural unit for work, for which it is responsible, for example, provision of consultations, organisation of training, and which are allocated to a structural unit as the result of calculations, on the basis of the volume of the planned works and/or indicators obtained in the previous periods (i.e., science support). In RTU for each structural unit director, remote access to operational financial information about the structural unit budget is provided, including the information about the planned volume of works and the corresponding financing in the next periods for implementation of the study programme and the study courses. At the beginning of each finance or budget year, the structural unit director plans the work of the structural unit, including salaries of the academic staff subordinated to the certain structural unit director and elaborates the procurement plan for the next year according to the provision of the study programme or the study course activities and development etc.

For the implementation of the study programme and achievement of the learning outcomes each year material and technical provision is assessed as well as the study and science provision base including printed and digital editions.

According to the volume of the programme financing, regular renewal and improvement of resources and software are performed.

In the implementation of the programme such material resource base is used:

- rooms (for both lectures and practical classes);
- modelling computer laboratories;
- experimental laboratories;
- methodological cabinet;
- RTU Scientific library book and periodic material storage.

There are other RTU infrastructure elements available for the needs of students and instructors - canteens and cafés, copying rooms, student hostels, RTU sport and recreation centres, swimming pools etc. In RTU rooms there are trading automates installed for buying various drinks and snacks, and drinking water is available free of charge. Information storages are regularly renewed and appended with regular and periodic leading world professional and scientific editions and books in the field.

The University library is of major importance for the implementation of the methodological and informative provision of the student. RTU Scientific library is the official state-level library, which obtained its status as a result of accreditation. The library provides all the necessary information for the RTU study process and research activities and performs library, bibliographic and information services for RTU students, academic staff, and employees. In the library collection, there are 1.4 million printed documents and e-resources in the databases corresponding to the RTU fields. Students have access to the databases, for which the RTU library is subscribed:

- **EBSCOHOST eBook Academic Collection** - eBook Academic Collection database contains ~202 200 books in various science fields: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life

Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.

- **IEEE Xplore Digital Library (IEEE/IET Electronic Library)** - IEEE Xplore Digital Library is the most extensive database packet, where all IEEE/IET full-text journals, conference materials, collections of scientific papers are available.
- **E-journal and e-book search** - with the help of SFX software it is possible to precisely define the location of an e-resource (e-journal, e-book) in the RTU Scientific Library subscribed and free access databases.
- **SpringerLink** database e-books, available are 18 500 e-books (issued within 2014 -2020) in the fields: of computer sciences; engineering sciences.
- **Web of Science** is the leading research platform of electronic resources. The unified platform provides an integrated approach for high-quality literature, it unites the search for information in bibliographic (also citation index) databases, helps find the newest and the most important scientific publications in the journals with high influence factor, collections of conference proceedings etc., as well as show citation of scientific publications.
- **Latvian standard database** content: Latvian national standards (LVS); European standards adapted to Latvian standard status (EN); International standards adapted to Latvian standard status (ISO); annexes to standards: amendments and corrections. Thematic arrangement corresponds to the internationally accepted International Classification for Standards (ICS). Standards can be searched by number and can be read.
- **EBSCOHOST -** EBSCO databases comprise periodical publications in computer sciences, engineering sciences, humanitarian and social sciences, economics, business, medicine and other fields.
- **ProQuest Ebook Central** (earlier Ebrary) database provides an opportunity to read scientific books in electronic format. In the ProQuest Ebook Central platform, a collection of electronic books «Academic Complete» is available, where about 200 000 e-books in English in PDF format are found, which were published by the world-leading scientific editions – Elsevier, Wiley, Springer, Oxford Press, Emerald etc.
- **ScienceDirect** is one of the largest databases of scientific, technical and medical articles in the world, which comprises full texts of Elsevier Science edition journals.
- **SCOPUS** (publisher Elsevier) – a bibliographic citation database of scientific literature, created by scientists for fast acquisition of information.
- **ACM Digital Library** offers high-quality publications in computer science – computer security, computer graphics, acquisition of information, mobile technologies, software development etc.
- **WILEY Online Library** database offers a packet of full text scientific reviewed journals „Full Collection".
- **Letonika** is a Latvian information and translation system on the Internet, the main objective thereof is to provide systematized encyclopaedic data and information on translation, by creating new, knowing the existing and maintaining digital resources about Latvia.
- **Learning material repository – MERLOT** The largest free access storage of learning materials in the world, which contains more than 28 000 materials and an opportunity to attach own learning materials. Here are also links to more than 500 other learning material repositories, creating unlimited opportunities for online browsing of learning material.

RTU FET Institute of Telecommunications provides academic and methodological work: creates and renews study course descriptions, provides instruction of the corresponding courses (including practical, laboratory and seminars classes), conduction of graduation papers and the defence thereof and performs other activities related to academic, methodological and scientific work.

The bachelor's academic study programme "Telecommunication Technologies and Data Transmission Engineering" has been implemented at the building of FET - Āzenes street 12, Riga.

The environment therein corresponds to the modern requirements. All the classrooms anticipated for the study process are equipped with multimedia devices - computers with access to the Internet, speaker system, and projector. Thus, it is possible to provide the modern study process. Students of the study programme “Telecommunication Technologies and Data Transmission Engineering” perform scientific research within the framework of their bachelor thesis and also laboratory work in one of the RTU Institute of Telecommunications laboratories or computer classes mentioned below:

- **Electrical Measurements Student Laboratory**

Anticipated student training within the bachelor course RDE709 “Electrical Measurements in Telecommunications” for laboratory works and graduation paper research work in the field of voice communication service quality assessment. In the laboratory, it is anticipated to acquire skills related to electric signals, as well as service quality measuring principles in the field of electronic communications. The list of measurements includes signal voltage and level measurements, time interval measurements, study of signal frequency spectrum, attenuation measurements, as well as the acquisition of voice communication service quality assessment principles. In 2018 for improvement of the laboratory of electrical measurements the equipment for voice communication service quality control solution was procured, which is a set of hardware and software (RTU inventory No 998350).

- **Transmission Systems and Access Networks Student Laboratory**

In the transmission system laboratory students study voice signal statistics and DTFM signalling using a telephone and a virtual signal analyser; get acquainted with signal discretization in time and quantization by levels (encoding), prove theoretical limitations; get acquainted with real E1 (2 Mbit/s) PS, perform measurements of channel characteristics and transmission errors; get acquainted with modulation type basics used in PS, perform measurements and signal analysis. In the access network laboratory, within the study course, “Introduction to Electronics and Telecommunications Branch” students develop practical works about important topics in the field of Electronics and Telecommunications (Internet of Things, Smart Home, sensor solutions, wireless network coverage assessment and improvement, microwave antenna solutions, voice transmission solutions).

- **Telecommunications Theory Measurement Student Laboratory**

The laboratory is anticipated for student training within the bachelor course, as well as for elaboration of laboratory work in Electrical Communication Theory, for skill improvement. In the laboratory, it is anticipated to acquire skills related to principles of continuous signal discretization and regeneration, discrete modulated or manipulated signal anti-jamming ability, use of error correction code in the transmission of information, as well as for transmission of electric signals for the acquisition of the informative and random signal interaction principles.

- **Digital Devices and Systems Student Laboratory**

In this laboratory, students acquire practical works related to the subject RAE362 “Digital Devices and Systems”. The training schemes include such topics: transistor operation in latch mode, differentiator and integrating circuits, signal generators, signal limiters and digital-to-analogue/ analogue-to-digital converters. The work task of the laboratory is to understand the principles of operation of various electric current circuits using measurements and computations and to compare the obtained results with those expected theoretically.

- **Digital Electronics and Computer Architecture Student Laboratory**

In this laboratory classroom, students acquire two bachelor study level subjects: RAE261 “Digital

Electronics and Computer Architecture" and RAE701 "Digital Devices of Telecommunications Systems". Within the framework of laboratory works students work with training schemes on such topics: as recognition of logic elements, combination logic devices, triggers, registers and counters. The task is to recognise various digital logic components and to obtain descriptive logical functions thereof using truth table results. The second cycle of laboratory work is anticipated for students to acquire basic principles of programming in assembly language. Various tasks are prepared, which are related to arithmetic and data storage operations, where the solution has to be presented in the form of assembly language code. The obtained solution is tested on the reprogrammable microcontroller scheme.

- **Transmission Media Student Laboratory**

In this laboratory, students acquire laboratory works on the subject RDE302 "Transmission Media". The tasks to be performed in the laboratory works are related to the recognition of various types of cable constructions, measurements and calculations of the primary and the secondary electrical parameters, reflectometric measurements and mutual influence parameter measurements in symmetric cables. During practical work, students have to make various measurements, computations and analyses of the obtained results.

- **Class of Communication Systems and Telecommunication Networks Mathematical Modelling**

The computer classroom is equipped with 16 computers with various simulations, computations, programming and designing software (Seamcat, HTZ Communication, OptSim for Optical Communication, Matlab, Autocad, Java, Python etc). In this computer classroom students acquire bachelor study level courses: RDE711 "Mobile Network Architecture", TRT441 "Computer Technologies in Research", RAE202 "Computer Technologies in Telecommunications", RAE348 "Telecommunications and Computer Networks", TRT461 "The C Programming Language".

- **Transport Network Performance Assessment and Radio Navigation Laboratory**

In this laboratory classroom students acquire bachelor study level courses: TRL534 "Computer Network Monitoring, Diagnostics and Maintenance", as well as perform practical works in the study project TRT313 "Real-Time Communication Systems". Thanks to "Mikrotīkls" LTD's support in 2021 the material and technical base of the laboratory was modernized. A powerful computer was procured for performing server functions, 2 interactive boards and 7 laptops. Special gratitude shall be expressed to "Mikrotīkls" LTD for various additional equipment (routers, stands, connections, fastenings), which allows for performing various data transmission experiments and demonstrations. The laboratory is equipped with all necessary devices, which allow the creation of communication systems and make assessment, modelling and analysis of network performance. Global computer network emulator Candela Technologies WAN Emulator; Computer network traffic generator Candela Technologies Traffic Generator; Computer network traffic analyser Agilent 76801A Distributed Network Analyzer; Mikrotik RouterBOARDS hAPac (IEEE 802.11ac standard); Routers Cisco 1841; Hewlett Packard wireless network controller MSM720 and access points MSM640; multi-channel GPS/SBAS Simulator; GNSS 72 channel GPS + GLONASS receiver, 1cm RTK precision.

- **Transport Electronics Laboratory**

In the laboratory, within the study course TRT203 "Semiconductor Devices" students get practically acquainted with semiconductor device operation principles and also study semiconductor devices in static and dynamic mode. In the study course TRT215 "Fundamentals of Circuit Theory" students acquire the fundamentals of electric circuits. For such purposes, there is a demo electronic control unit (ECU). When connecting it to a diagnostic tool (ELM-327) it is possible to observe actual parameters and also to read diagnostic error codes. At the same time, using the oscilloscope, there is a possibility to observe signals from various sensors, and using logic analyser, to observe information exchange, which is done through the diagnostics line. Using the CAN Bus analyser students study auto transport data communication lines with protocols: ISO 11898-2, ISO 11898-3 and LIN V1.3/V2.0/2.1.programmable read-only memory and get acquainted with the basics of designing telecommunication devices.

In the period from 2013 until 2022 for the needs of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” for provision of the study process RTU TI procured infrastructure for laboratories, practical classes (i.e., modelling computer software) and lectures (i.e. scientific literature, scientific article databases), computer hardware (monitors, computers, presentation lasers), laboratory equipment (analyser ELQ-2, oscilloscope GDS-1052-U, transmission error coefficient meter TLP-3c, virtual tool PicoScope, sensor signal processing and analysing equipment (HW Group): Poseidon 2, STE2, WLD2, sensors (temperature, air humidity, light intensity), detectors (door contact, light flux, motion, smoke, vibration, power), Amplifi access point with amplifying antennas, NonoBeam M5 microwave antennas, learning sets for voice transmission and plastic optical fiber and free space optics etc., 11 desktop computers (Capital NEO GX33 MT, LCD monitors, keyboards, mice), micro controller learning sets (12 pcs. Arduino UNO starter kit and IoT trainer kit).

For all study courses, methodological materials are regularly updated and uploaded by the teaching staff in the ORTUS environment.

The study process is provided mostly by the staff of RTU FET Institute of Telecommunications. In addition to the compulsory part (A part), the professional specialisation part (B1 part), the humanitarian and social study course part (B2 part) and the language study course part (B6 part) such structural units are involved:

- Engineering Mathematics academic Department
- Optics Academic Department
- The Academic Department of the Theory of Probability and Mathematical Statistics
- Study department
- Labour and Civil Defence Academic Department
- Environment Protection and Heat System Academic Department
- Electronic Hardware Academic Department
- The Academic Department of Fundamentals of Electronics
- Social Science Academic Department
- Engineering Pedagogy and Psychology Academic Department
- Special Application Language Department
- Technical Translation Department

For the provision of quality, a digital student survey system is used, which helps in controlling the quality of study courses and study programme implementation each semester. On the basis of the quality control results, regular measures for improvement of the study programme and processes are performed.

The total assessment of the resources is reflected in the data provided in part II Section 3, criteria 3.1.-3.3. of the Study Field Report.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and

higher education institutions (applicable to doctoral study programmes) (if applicable).

Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The financing source of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" is the funds of the state budget and tuition fees of natural persons.

In the 2021/2022 study year, the programme has 137 state budget financed seats. The tuition fee for the academic bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" is 4000 EUR.

Table 3: Information on the financial resources of the programme is reflected below:

Study year	Grant for the programme, EUR	Tuition fee for the programme, EUR		Total financing for the programme, EUR	Financing of one state budget seat, EUR
		Tuition fee for local students, EUR	Tuition fee for international students, EUR		
2013/2014	698543,00	3842,00	-	702385,00	3866,00
2014/2015	631687,08	704,32	-	632391,40	3866,02
2015/2016	481223,60	-	8563,78	489787,38	3866,02
2016/2017	460497,81	-	32590,67	493088,48	3866,02
2017/2018	474240,77	360,00	23898,36	498499,13	4040,66
2018/2019	494114,13	-	25283,11	519397,24	4229,68
2019/2020	533175,81	-	28045,05	561220,86	4405,04
2020/2021	555878,41	-	34386,08	590264,49	4462,81

The financing of one study seat has increased - in the academic year 2020/2021 by 14% in comparison to the academic year 2013/2014.

RTU's funding from the state basic budget consists of study base funding corresponding to the list of study programs and the number of students, which consists of funds for utility payments, taxes, infrastructure maintenance (including providing data to the Register of Students and Graduates), the purchase of equipment and equipment, and staff salaries, as well as funding for scientific activity and business trips.

The financial resources of the study program "Telecommunications Technologies and Data Transmission Engineering" are partly sufficient for the implementation of the study program and their use is regularly controlled both by the administration and the financial vice-rector of RTU.

The available funding is mainly used to pay for the work of teaching staff, as well as to maintain and improve the teaching infrastructure. The implementing structural unit – the Institute of Telecommunications is responsible for specific financing tasks. Funding decisions are made at the department, institute or faculty level. Significant efforts are devoted to enriching the skills and abilities of teaching staff, therefore part of the funding is devoted to paying for various courses, seminars, business trips, as well as academic vacations. Also, the investment for the addition of equipment is systematically planned.

More detailed information about the distribution of the funding among cost items is given in the self-assessment report of the study field in the annex “Distribution of funding among the cost items”

Information about the minimal number of students in the programme is given in the self-assessment report of the study field in the annex “On_minimal_number_of_students_in_study_programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The teaching staff of various levels and professional qualifications are involved in the implementation of the study programme to make the implementation of the study courses of the programme as qualitative as possible. In total in the implementation of the bachelor's academic study programme 9 professors, 7 associated professors, 14 docents and 14 lecturers, 4 researchers and 3 assistants/scientific assistants are involved.

During the review period, more than 20 new members of the teaching staff joined the implementation of the study programme by supplementing the research field list and opportunities for students to choose a supervisor for a graduation paper, who is a professional in the corresponding research field. Qualification of the teaching staff of the programme study courses corresponds to the programme implementation requirements. Highly qualified scientists and field specialists take part in the programme implementation.

The basis of the selection and renewal of a qualification improvement policy of the academic staff is the regular involvement of master’s students and master’s study graduates and doctoral students in the study process.

Qualification of the teaching staff involved in the implementation of the study programme fully corresponds to the study programme implementation conditions and requirements of the normative acts, provides achievement of the corresponding study programme and study course objectives, tasks and study results (see CVs of the teaching staff). RTU elected teaching staff, guest lecturers and leading experts in the field are involved in the implementation of the bachelor’s study programme “Telecommunication Technologies and Data Transmission Engineering”. RTU elected staff is responsible for the content of the study course and the creation thereof. In the bachelor’s study programme, the responsible teaching staff have the corresponding education. RTU elected academic staff and guest teaching staff of the field also take part in the implementation of the programme.

According to the study programme tasks, the primary criteria for selection of the teaching staff are:

1. knowledge about the newest technologies and participation in scientific and research projects in their fields,
2. pedagogical skills corresponding to the modern trends in the field;
3. experience in teaching study courses to foreign students in English.

To provide quality with the study courses, the teaching staff involved in the implementation of the programme regularly improve their professional and academic knowledge at methodological seminars, and conferences (on a national and international scale), as well as in research and scientific work (see CVs of the teaching staff), take part in various scientific and methodological projects

There are 6 professors from RTU FET Institute of Telecommunications, who take part in the implementation of the study programme - doctors of science, who are elected as professors and whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for a professor’s position. Elected professors: Dr.sc.ing. Vjačeslavs Bobrovs, Dr.sc.ing. Ģirts Ivanovs, Dr.sc.ing. Jurģis Poriņš, Dr.sc.ing. Sandis Spolītis, Dr.sc.ing. Ernests Pētersons, Dr.sc.ing. Andris Ozols.

To summary reports about the qualification of RTU FET Institute of Telecommunications professors (as was mentioned before, 67% of all the teaching staff are professors of RTU FET Institute of Telecommunications, from other structures - 33%) are given below:

Vjačeslavs Bobrovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: dean of FET. Professional experience: academic and scientific work experience of more than 15 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics, wavelength division multiplexing, passive and active optical networks, microwave telecommunication systems, mobile networks, wireless communication systems), natural sciences - Physics and Astronomy (optical processing physics, conference, optical waveguides, lasers, optical elements, fibre optical elements), engineering sciences and technologies – nanotechnology (nano particles, nano photonics, nano aerials, metaphotonics, anapole state, anapole dynamics, integrated photonics). Director of the academic bachelor’s study programme “Telecommunication Technologies and Data Transmission Engineering”, the academic master’s study programme “Telecommunication Technologies and Networks Management” and the academic doctoral study programme “Telecommunications”.

Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, RTU Scientific Council, member of the Senate and Constitution Board, member of the RTU Electronics, Information and Communication Technologies, Computer Sciences and Information Science. Member of IEEE since 2012. Co-author for 182 scientific publications, which are available in the Scopus database, and his H-index is 13, co-author for 17 patents. Researcher or project manager in more than 15 projects in total. More than 80 bachelor papers, 85 master papers and 7 promotion papers are advised and successfully defended. Participated in ERASMUS academic staff exchange. Regularly participates in professional training and academic seminars.

Jurģis Poriņš, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: Head of Group. Professional experience: academic and scientific work experience of more than 27 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics; non-linear fibre optics; non-linear optical effects in fibre optics transmission systems; optical wavelength division multiplexing systems and elements; optical amplifiers; safety parameters in communication lines; sensors and sensor networks), natural sciences - Physics and Astronomy (non-linear fibre optics, study and application of non-linear fibre optics effects, polarization effects and assessment thereof, laser equipment, optical amplifiers, optical frequency combs and application thereof). Expert of the Latvian Council of Science (LZP) since 2012 and corresponding member of the Latvian Council of Science (LZP) since 2018. Director of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, Director of FET Council. From 2015 until 28.02.2022 was the dean of FET and administered the Faculty. Member of RTU Council since 01.03.2022. In total there are 87 publications published in internationally cited editions and reviewed scientific editions and conference proceedings (from them 52 in Scopus database, H-index is 8), as well as 8 scientific monographs, which are available in EBSCO, ISI WEB of Science, INSPEC, VINITI, VERITAS, Intech and other databases. There are 7 articles published in popular science journals. Participated with theses in 82 international and Latvian scientific and technical conferences. Also participated in panel discussions 5G Techritory forum 2020, LU Student scientific conferences in the discussion about the influence of COVID-19 on science and in other events, as well as took the floor radio broadcasts LR1 “Known in the unknown” (in Latvian: "Zināmais nezināmajā"), and also on television broadcasts TV3 and LTV7. 56 bachelor papers, 62 master papers and 2 promotion papers are advised and defended. Implements 8 study courses, as well as qualification upgrading courses for representatives of the field of telecommunications. Co-author for 12 patents. Researcher or project manager in 7 projects in total.

Ģirts Ivanovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. More than 40 years of experience in the field of higher education: administration of the study process, scientific research, and project management. LZP expert in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies (electrical communications, microwaves, optics, fibre optics, WDM, filters, optical filers, PON, optical amplifiers). For more than 10 years he has been the director of the Institute of Telecommunications and the director of the academic bachelor’s, master and doctoral study programme “Telecommunication”. Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, member of Institute of Telecommunications Council, and Member of the Board of the Latvian Telecommunication Association for more than 10 years. Co-author for 85 scientific publications, which are available in the Scopus database, and his H-index is 11, and co-author for 11 patents. The professor implements study courses: “Communication Transmission Lines”, “Fiber Optic Transmission Systems”, “Electrodynamics of Driving Systems” and “Optical Transmission

Lines”, as well as participates in the elaboration of the bachelor papers as a scientific advisor. More than 35 bachelor papers, 40 master papers and 4 promotion papers are advised and successfully defended. Researcher or project manager in more than 10 projects in total.

Sandis Spolītis, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Communication Technologies Research Centre: head of the centre. Scientific research directions: research and development of innovative fibre optics communication systems, signal processing and coding, optical frequency comb sources, radio over fibre systems, optical processing physics, optical elements and components. Published >80 scientific articles (indexed SCOPUS), 2 monographs. Co-authors of 5 Latvian patents, H-index 10. Participation in >10 international conferences with theses (verbal and stand messages). Advised and successfully defended 18 bachelor and 17 master papers, 5 promotion papers (2 are defended), administration of the study courses of RTU Faculty of Electronics and Telecommunication, Institute of Telecommunications “Telecommunication systems”, “Scientific workshops in the field of telecommunications” and “Scientific workshops”. The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Traineeships in the Photonics Institute of the Technical University of Denmark and in the Photonics Technologies Integration Centre of the Photonics Integration Institute of Eindhoven Technical University. Member of the RTU Promotion Council RTU P-08 “Electric equipment, Electronics, Information and Communication Technologies”, member of the RTU Constitution Board, member of the Council of RTU Faculty of Electronics and Telecommunications, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of “Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies” and “natural sciences - Physics and Astronomy”. Participation in international scientific associations – IEEE and SPIE. Reviewer of scientific articles of high influence (Applied Sciences, IEEE Access, Micromachines, Chinese Optics Letters, Fiber and Integrated Optics, Optik, Optics Letters) and a member of international scientific conferences- FOAN, RTUWO, MTTW technical programme committee (TCP).

Andris Ozols, Dr.habil.phys., professor, senior researcher, RTU, Faculty of Materials Science and Applied Chemistry (MLĶF), Technical Physics Institute, Optics Group; Head of Group. Chair of RTU Natural Sciences, Physics and Astronomy Professor Council. The direction of scientific research is material optics, dynamic holography, physics of optical recording and transmission of information. More than 50 years of experience in the field of higher education: administration of the study courses, scientific research, and project management. Since 1998 A. Ozols has been a corresponding member of the Latvian Academy of Science, but since 2010 he is an academician of LZA. From 2010 until 2016 A. Ozols was elected as a member of the commission of experts of Natural Sciences and Mathematics of the Latvian Council of Science and currently he is a vice-chair of the LZA Physics and Technical Sciences Department. Concurrently to the above mentioned, A. Ozols is also a vice-chair of the Joint Council of Astronomy and Physics Professors of RTU and Daugavpils University. LZP expert in the fields of engineering sciences and technologies - Material Science (Solid State Physics, Holography, Laser Spectrography, Photo Induced Processes in Matter, Nano structures, Information Technologies). In 2017 professor Andris Ozols received a Certificate of Appreciation from the Cabinet of Ministers for significant contribution to the development of optical technologies and for active participation in the work of Latvian Academy of Sciences. The total number of works: scientific – 253, including 131 scientific articles, from which 75 are published in cited scientific journals; 11 methodological works; 37 popular science articles. The professor is the advisor for bachelor, master and doctoral level students in the subjects related to nanophotonics, theory of electrical communications, physics, signal transmission theory, optical record physics, nano structured nano materials.

Ernests Pētersons, Dr.sc.ing., professor, the academic department of Telematics and Transport Electronic Systems of RTU FET Institute of Telecommunications. Directions of scientific research: the main direction of research is connected with theoretical and experimental study of traffic in transport wireless networks and with practical application thereof for improving network performance. Published >60 scientific articles (indexed SCOPUS), 5 monographs, H-index 4. More than 40 bachelor and master theses, and 7 promotion papers are advised, conducts the study courses of the academic department of Telematics and Transport Electronic Systems of RTU FET Institute of Telecommunications “Computer Networks”, “Information Compression and Encoding Theory”, “Cryptography and Data Security Technologies”, “Network Analysis and Design”, “Communication in Transport Intellectual Systems”, “Real-Time Communication Systems”, “Communication System Models”. Active participation in other educational institutions in Latvia by reviewing promotion papers, including the LU Institute of Mathematics and Computer Science. In total, by working in various state educational institutions in Latvia he prepared 22 highly qualified specialists with a doctor’s degrees. The experience of project manager and executor in various state and internationally financed scientific research projects – RTU scientific research platform project, State research programme and ESF projects. Practical scientific cooperation within the last years has been with the prof. Aļģimantas Kajackas from Vilnius Technical University and the prof. Vladimir Vishnevsky from the Management Problem Institute of the Russian Academy of Sciences. A member of RTU Promotion Council RTU P-08 “Electric equipment, Electronics, Information and Communication Technologies” (in the last six years 6 promotion papers are reviewed), a member of RTU Faculty of Electronics and Telecommunications Council, Latvian Council of Science expert in the fields of “Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies. Participation in international scientific associations – IEEE. A member and reviewer of the editorial board of the journal Automatic Control and Computer Sciences. Appreciations: Emeritus prof. honoured title, several appreciations for preparation of highly qualified specialists, and honoured Lifetime IEEE membership.

There are 2 associated professors from RTU FET Institute of Telecommunications, who take part in the implementation of the study programme - doctors of science, who are elected as associated professors and whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for an associated professor’s position. Elected associated professors: Andis Supe, Dr.sc.ing., Aleksandrs Ipatovs, Dr.sc.ing.

To summary reports about the qualification of RTU FET Institute of Telecommunications associated professors (as it was mentioned before, 33% of all the teaching staff are associated professors of RTU FET Institute of Telecommunications, from other structures - 69%) are given below:

Andis Supe, Dr.sc.ing., associated professor, senior researcher, RTU FET Institute of Telecommunications Telecommunication Network Group. Large scientific work experience in the field of fibre optical transmission systems. Participated in the successful implementation of many European Regional Development Fund (ERDF) and European Social Fund (ESF) projects, as well as Latvian National Research Programme. In the period from 2018 until 2020, A Supe implemented the post-doctoral project “RETUNE”, which focused on signal regeneration using non-linear optical effects. During the implementation period of the post-doctoral project international research work experience was obtained in the Telecommunication Institute of Aveiro University, A. Supe is a co-author of more than 30 international publications (Scopus data), co-author of 6 Latvian Patents and a member of the international IEEE conference MTTW TCP. He is involved in the Latvian Council of Science as an expert in the field of electronics and telecommunications. A. Supe has more than 8 years of academic work experience teaching subjects at bachelor’s, master and doctoral levels. 23

bachelor papers and 16 master papers are advised and defended.

Aleksandrs Ipatovs, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Institute of Telecommunications, Head of Telematics and Transport Electronic Systems Group. Scientific research fields: elaboration and research of Telematics and Transport Electronic Systems, Signal Processing and Encoding, Wireless Networks, Computer Network Traffic Analysis, Assessment of Computer Network Performance. Published >26 scientific articles (indexed in SCOPUS). H-index 4. Participation in >10 international conferences with theses (verbal and stand messages). 10 bachelor papers, 3 master papers and 4 promotion papers are advised. Implemented study courses "Fundamentals of Computer Architecture", "Transport Real-Time System Maintenance", "Management of Intellectual Transport System", "Introduction to Computers and Algorithms", "Computer Technologies in Research", "Network Databases and Data banks". The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Member of the RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies" (1 promotion paper reviewed), member of the RTU Constitution Board, member of the Council of RTU ETF, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies". Participation in international scientific associations – IEEE and SPIE. A reviewer of international high influence scientific journal articles and a member of the technical programme committee (TCP) of the international scientific conferences - RTUWO, MTTW.

The academic staff involved in implementation performs scientific research at the international level by improving their own qualifications and performing scientific and research activities (see CVs of the teaching staff). The academic staff have an opportunity to append professional knowledge and obtain valuable experience in one of the international higher educational institutions (using opportunities for mobilities of Erasmus or other projects), which is reconciled with the European education space development strategy, as well as to have traineeships in the enterprises.

In the implementation of the study course (lectures, practical works, laboratory works) the responsible teaching staff also attract candidates for the doctor's degree. Examples,

- in the implementation of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" study courses "Introduction to Electronics and Telecommunications Branch", "Transmission Systems" and "Transmission Media" takes part a candidate for the doctor's degree, the lecturer Jānis Braunfelds.
- in the implementation of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Research Seminars in the Field of Telecommunications" takes part a candidate for the doctor's degree, the lecturer Laura Skladova.
- in the implementation of the bachelor study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Telecommunications Systems" takes part a candidate for the doctor's degree, the lecturer Armands Ostrovskis.
- in the implementation of the bachelor study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Telecommunications Theory" takes part a candidate for the doctor's degree, the lecturer Rihards Mūrnieks.
- in the implementation of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Electrical Measurements in

Telecommunications" takes part a candidate for the doctor's degree, the lecturer Inga Vagale.
- in the implementation of the bachelor study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Computer Technologies in Telecommunications" takes part a candidate for the doctor's degree, the lecturer Toms Salgals.
- in the implementation of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" study course "Mobile Network Architecture" takes part a candidate for the doctor's degree, the researcher Lilita Ģēģere.

The RTU FET Institute of Telecommunications academic staff involved in the implementation of the bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering" is highly specialized and with large scientific experience.

In total, the qualification of all members of the teaching staff corresponds to the implementation conditions and the normative acts of the study programme, as well as provides acquisition of study programme objectives and study results, which is proven by their qualification and curricula vitae.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

Both academic teaching staff and highly qualified experts from various fields are involved in the implementation of the study programme to make the implementation of the study courses of the programme as qualitative as possible.

In the implementation of the study programme 9 professors, 7 associated professors, 14 docents and 14 lecturers, 4 researchers and 3 assistants/scientific assistants are involved. Professors and associated professors are doctors of science, whose scientific and pedagogical qualification corresponds to the assessment criteria defined in the normative acts about the scientific and pedagogical qualification of a candidate for a professor's position.

Analysing the changes, there are several reasons:

1. In the review period, associated professors and docents have raised their qualifications and became professors, or docents became associated professors;
2. The teaching staff took part in grant competitions, where received financing and an opportunity to make research in the field thus changing their academic position to the position of a senior researcher;
3. New experts in the field have been employed, and this promoted introduction of new technologies into study courses, therefore lecturers and assistants joined the implementation of the programme.
4. A part of the academic staff retired.

Almost in all groups of the teaching staff the average weighted age of the academic staff decreased. Changes can be observed in the table below.

Table 4: Changes in the teaching staff in the programme

Teaching staff	2013/2014		2020/2021	
	Number	**Average age**	**Number**	**Average age**
Professor	3	65	9	59
Assoc. professor	2	56	7	43
Docent	11	56	14	48
Lecturer	8	26	14	40
Researcher	-	-	4	37
Assistant/Scientific assistant	-	-	3	30
TOTAL	**24**	**51**	**51**	**42**

In the implementation of the programme new qualified teaching staff are involved, thus moving the content of the programme closer and closer to the specifics and the relevant topics of the field.

The basis of the selection and renewal of a qualification improvement policy of the academic staff is the regular involvement of master's students and master's study graduates and doctoral students in the study process. At the moment 7 faculty lectures are doctoral students, who promote the introduction of new learning methods as well as the relation of the study process with their own scientific research.

Currently, RTU implements the European Social Fund financed project SAM 8.2.2. "Strengthening of Riga Technical University academic staff in strategic specialisation fields", where one of the tasks is the renewal of the academic staff. The objective of the project is to strengthen RTU academic staff in strategic specialisation fields in 10 study directions. The project activities are in three directions:

- involvement of doctoral students in RTU academic work;
- the attraction of foreign academic staff to RTU;
- improvement of competencies of the existing academic staff, including traineeships of the academic staff in companies.

During the project, it is also possible for the academic staff to take professional English language courses and specialised courses.

The academic staff is stable and regularly takes part in various events related to the improvement of qualifications. Improvement of qualification is done by the academic staff through participation in academic and scientific conferences and seminars, and acquisition of various courses. The findings obtained during the improvement of qualification and during the scientific work are embedded into the learning process.

The teaching staff of the programme take part in local and international conferences, which is reflected in the curricula vitae of the teaching staff.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in

Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Mutual cooperation among members of the teaching staff is done within the study programme, starting from planning of the study year and reconciliation of the study course project tasks at regular methodological seminars, and continues within the whole semester through teaching the training courses, planning the necessary changes for each semester and for the programme in general.

Various cooperation channels are available for the academic staff:

- **Online conference platforms (ZOOM and MS Teams)** – technical support is provided for everyday cooperation – discussions, meetings and idea and opinion exchange;
- **E-Learning environment** – mutual cooperation of members of the teaching staff is provided, as well as cooperation with students of the study course. The main functions, which are provided by the E-Learning environment, study content management, assessment methods and management, communication with students, administration of tests;
- **Councils of structural units and institutes** – a specialised discussion of representatives of a certain field or the study programme about aspects, content, assessment methods, achieved results of study course implementation as well as discussion of other issues related to the implementation of the study programme;
- **Annual seminars and academic conferences** – the teaching staff discuss and share

experience on the newest trends in study methods, and introduction thereof. Organised according to the needs.

Each year the study courses of the programme are regularly improved, based on both - recommendations from students and tendencies of the field. During the study courses, regular meetings and methodological seminars of the teaching staff are held, where experience exchange about study course topics take place, and also the content of study courses is elaborated and improved through mutual agreement on topics, directions, responsibilities and correspondence to the normative requirements. In the process, of course, reconciliation all members of the teaching staff are involved, who are taking part in the implementation of a certain study course, providing that the topics included in the study programme are continuously being improved and renewed in cooperation with the professionals involved in the field.

In planning and inclusion of new study courses into the study programme it is mutually reconciled that study courses do not overlap and provide students with the necessary basic knowledge in each field. When reviewing and actualising a study programme, the teaching staff agree on the most applicable and efficient solutions with respect to the assessment of student achievements and the acquisition of results. When planning a study year and making an agreement on project tasks of the study courses, the disadvantages found before are taken into account and corrections are performed.

When analysing the ratio of students to teachers in the study programme, at the time of submission of self-assessment there are 4 students for one elected member of the teaching staff and for 12 students - one specialist of the field.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_EBG0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_EBG0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	NR_37_RTU_bk_250_stud.zip	Nr_37_RTU_bk_250_stud.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EBG0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EBG0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_EBG0(43526)_CompliancewiththeStateEducationStandard_AkadBak_ENG.pdf	P06_3.2.1_EBG0(43526)_AtbilstibaValstsStandartam_AkadBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EBG0(43526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EBG0(43526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EBG0(43526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_EBG0(43526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_EBG0(43526)_StudyCoursesdescr_ENG.zip	P10_EBG0(43526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Transport Electronics and Telematics (47523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Transport Electronics and Telematics*
Education classification code	*47523*
Type of the study programme	*Professional master study programme*
Name of the study programme director	*Aleksandrs*
Surname of the study programme director	*Ipatovs*
E-mail of the study programme director	*aleksandrs.ipatovs@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*+37129689893*
Goal of the study programme	*The aim of the study programme is to train specialists of internationally recognized level with a professional master's degree trained to perform design and technical operation works for transport electronics and telematics systems in the following fields: transport radio systems, transport telecommunications, transport computer systems and networks, aviation communication systems, railway transport communication and information systems. To teach professionals skills of analytical thinking, modelling, developing, implementing, and managing new engineering solutions. In addition, to develop ability of the students conduct a research and experimental work, participate in local and international projects, and continue their doctoral studies.*
Tasks of the study programme	*The tasks of the study programme are: - to provide competitive higher education in accordance with international standards, and to prepare students for work in the field of telematics and transport electronics systems, also to develop skills of scientific research work and to promote their use; - to provide students with knowledge on application, analysis and design of telematics tools, combined with knowledge on physical processes and circuit technical solutions used in transport electronics; - to provide comprehensive knowledge to students to develop skills and competence in accordance with the requirements defined by labor market for leading electronics engineers; - to promote students' interest in social processes, to stimulate maturing of students into a positive, modern, responsible personalities able to act independently and make independent decisions; - to ensure development of the study programme content, study process implementation, and scientific research work in accordance with changes in the field of quality management, international practice, scientific and pedagogical practice; - to promote interest of students in further professional development by providing knowledge and skills for independent studies to increase the academic and professional qualifications.*

Results of the study programme	*Graduate of the study programme: - can manage transport computer networks, understand their internal processes; - can design, develop, and operate electronic equipment and telematics systems. Perform its testing, analysis, operation modelling and improvements in accordance with requirements of the standards and develop the appropriate technical documentation; - can utilize latest technologies and software for design and production processes of electronic equipment and systems; - can participate in research projects and provide assistance in pedagogical work; - can evaluate human resources and create a project working group, delegate work tasks and control their execution, present the progress and results of the project; - is proficient at concept level in latest telematics and electronic equipment manufacturing technologies, industry standards and technical norms; - is proficient at application level in signal processing, telecommunications theory, data coding and protection (cryptography) and training neural networks; - is proficient at application level in construction and design of telematics equipment, transport intelligent data transmission systems and sensor networks; - is proficient at application level in programming microcontrollers and microprocessors by using high-level languages.*
Final examination upon the completion of the study programme	*State examination, which includes the development and public defense of a master thesis.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor degree of engineering science in electronics, telecommunications, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional master degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 1 years, 6 months - latvian

Study type and form	*Full time studies*
Duration in full years	*1*
Duration in month	*6*

Language	*latvian*
Amount (CP)	*60*
Admission requirements (in English)	*Professional bachelor degree in transport electronics and telematics and professional qualification of electronic engineer, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional master degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor degree of engineering science in electronics, telecommunications, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional master degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 1 years, 6 months - english

Study type and form	*Full time studies*
Duration in full years	*1*
Duration in month	*6*
Language	*english*
Amount (CP)	*60*
Admission requirements (in English)	*Professional bachelor degree in transport electronics and telematics and professional qualification of electronic engineer, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional master degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The professional master's study program “Transport electronics and telematics” has been implemented since 2004. The latest accreditation certificate for the study programme was issued on 31.05.2013. (certificate No. 2020/80). There are 2 implementations of the study programme: 1-st implementation of 60 CP (90 ECTS), 2-nd implementation of 80 CP (120 ECTS). The only implementation form of the study programme is full-time studies (1,5 or 2 years). The full-time studies of the study programme are implemented according to standard RTU plan: 2 semesters per study year, each is 20 weeks long – 16 study weeks and 4 session weeks.

The admission requirements are as follows:

For the 1-st implementation – professional bachelor's degree in transport electronics and telematics and qualification of an electronics engineer's, or equivalent education;

For the 2-nd implementation – bachelor's degree in electronics, telecommunications, or equivalent education.

The place of the study program implementation – Riga. The study program is being implemented in Latvian and English languages.

During the review period of the study programme, the following significant changes were made to improve the study programme and a form of preparing professionals of internationally recognized level.

The following significant changes to the study programme were introduced after the date of the previous study field certificate was issued:

1. the profession classification code was changed from 2151 01, 2151 20 to 2152 01;
2. the part-time and extramural implementation forms of studies were excluded. Since 2017, all students of part-time study programme were transferred to full-time study programme and admission to part-time study programme was discontinued;
3. the responsible institution has been changed from 13010 Transport electronics and telematics group to 13107 Telematics and transport electronic systems group;
4. the volume of the 2-nd study programme implementation was reduced from 100 CP to 80 CP;
5. a new director Asoc. Prof. Aleksandrs Ipatovs was elected to manage the study program;
6. all the study programme course specializations were removed;
7. the following changes were made to the compulsory study courses part (A):
    - the following study courses were **excluded** from the compulsory study courses part (A): EDS510 Technical Electrodynamics 3KP, TRL550 Network Operating Systems 3KP, TRT407 Theory of Information Compression and Encoding 3KP, EDS509 Transportation Fiber Optical Networks and Systems 3KP, TRT403 Theory of Digital Communication Systems (special course) 4KP;

- the following study courses were **included** to the compulsory study courses part (A): RDE701 RDE701 Telecommunications Theory (special course) 5CP, TRL342 Cryptography and Data Security Technologies 4CP, TRL446 Methods of Transport Real-Time System Performance Evalution 4CP, TRT306 Digital Signal Processing in Transport Telecommunications Systems 3CP;

8. the volume of compulsory elective study courses part (B) was increased from 8 CP to 11 CP, the volume of field-specific compulsory elective study courses part (B1) was increased from 6 CP to 11 CP and humanities and social sciences study courses part (B2) with volume of 2 CP was completely excluded from the program:

    - the following study courses were **excluded** from the field-specific compulsory elective study courses part (B1): TRL446 Methods of Transport Real-Time System Performance Evalution 4CP, TRT428 Air Traffic Control Automated Systems 4CP, TRL520 Computer Network Marketing and Economics 2CP, TRT501 Optimum Reception and Communication System Noise Immunity 2CP, EDS508 Design of Cellular Mobile Communication Systems 2CP, RRI592 Statistical Radio Engineering 2CP, EDS502 Transportation High-speed Digital Transmission 4CP, EDE448 Railway Communication Systems 5CP, TRT306 Digital Signal Processing in Transport Telecommunications Systems 3CP, EDE460 Railway Digital Transfer Information Systems 4CP, TRT405 C++ Programming Language 3CP, TRT408 Vehicle Location Systems 4CP, TRT506 Modelling of Transport Radio-Electronic Systems 3CP, TRL551 Telematic Services in Telecommunication Networks 2CP, TRL512 Cryptography and Data Security (special course) 2CP, EDE513 Railway Haulage Operation Computer Aided Technologies 6CP;
    - the following study courses were **included** to the field-specific compulsory elective study courses part (B1): TRL550 Network Operating Systems 3CP, RDE419 Fibre Optic Transmission Systems 5CP, RDE410 Design and Maintenance of Telecommunications Networks 4CP, RAE419 Telecommunications Marketing 2CP, REA407 Design Technologies 3CP, RTR802 Advanced Electromagnetic Simulations Methods and Software 4CP, REA703 Data Transmission in Wireless Sensor Networks 3CP;

To provide a modern education compliant to demands of the field, the changes introduced to the study programme aim to improve the study process and its quality by considering recommendations received from leading field enterprises and graduates, as well as development trends of modern technologies.

The following changes are planned to be implemented during the procedure of the study field evaluation:

1. to change admission requirements for the 1-st implementation (60 CP) from “professional bachelor degree in transport electronics and telematics and/or 5-th level Professional Qualification or comparable education” to “professional bachelor degree in transport electronics and telematics and electronics engineer qualification or equivalent education”;
2. to change admission requirements for the 2-nd implementation (80 CP) from “bachelor degree of engineering science in electrical science” to “bachelor degree of engineering science in electronics, telecommunications or equivalent education”;
3. to change the degree and qualification assigned for the 1-st implementation (60 CP) from “master degree in transport electronics and telematics” to “professional master degree in transport electronics and telematics and qualification of leading electronics engineer”;
4. to change the degree and qualification assigned for the 2-nd implementation (80 CP) from “professional master degree in transport electronics and telematics and qualification of electronics engineer” to “professional master degree in transport electronics and telematics

and qualification of leading electronics engineer".

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The professional master's study programme "Transport Electronics and Telematics" is elaborated in accordance with the Law on Higher Education Institutions of the Republic of Latvia and in accordance with Classification of Education of the Republic of Latvia.

For implementation and development of the study programme in the course of time, principles of Latvian classification infrastructure (LKI) and European classification infrastructure (EKI) are observed.

The study programme is developed taking into account RTU strategic objectives, market offers and potential demands.

The study programme is elaborated according to the RTU strategy and the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science". Acquisition of knowledge and skills anticipated in the study programme is provided by the academic staff and scientists of the European level. The study programme combines several fields of science: telematics, transport electronics, computer science and cryptography. This ensures the training of wide profile professionals, who are able to solve multi-functional telematics tasks and design, deploy and manage new electronic devices in transport telematic systems based on modern technologies.

The study program is included in the study direction "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which is characterized by a set of study programs whose main focus is on the use of technology and scientific knowledge specific to the direction in the study process.

The duration of studies is 1,5 or 2 years, and the volume of study courses to be completed amounts to 60 or 80 CP.

The title of the study programme "Transport Electronics and Telematics" is fully in line with study direction "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science" since electronics is included in the title of the direction as an integral part. At the same time, telematics is based on the fields of Telecommunications and Informatics (Computer Science), which also match the study direction.

The study programme's classification code 47523 - "Electronics and automatics" was chosen based on relation of the study programme title, goals, contents and assigned degree to electronics and telematics, which also includes automation solutions and corresponds to engineering sciences.

Applicants with an engineering academic or professional bachelor's degree can be admitted to the study programme. The graduates of the study programme will acquire **professional master's degree in transport electronics and telematics** and **qualification of a leading electronics**

engineer. Graduates of the study programme can continue their doctoral studies.

During the implementation of the study programme, innovative study methods are used -the use of more practical and modern technologies.

The strategical objective within the framework of the existing RTU strategy is to provide internationally competitive higher-quality scientific research, higher education, and technology transmission in the field of telecommunications by formulating strategical tasks of the faculty - qualitative study process, excellent research, sustainable commercialisation/valorisation.

The acquisition of skills and knowledge envisaged by the study programme is provided by highly qualified academic staff and scientists of European level with many years' experience involved in professional State and international expertise in their daily life. The implementation of the study programme relies on innovative study methods – more practical knowledge and applications of modern technologies. The professional master's study programme admission process is regulated by RTU Senate approved "Admission rules for academic and professional study programmes".

The aim of the study programme is to train professionals of internationally recognized level with a professional master's degree trained to perform design and technical operation works for transport electronics and telematics systems in the following fields: transport radio systems, transport telecommunications, transport computer systems and networks, aviation communication systems, railway transport communication and information systems. To teach professionals skills of analytical thinking, modelling, developing, implementing, and managing new engineering solutions. In addition, to develop ability of the students conduct a research and experimental work, participate in local and international projects, and continue their doctoral studies.

The tasks of the study programme are:

- to provide competitive higher education in accordance with international standards, and to prepare students for work in the field of telematics and transport electronics systems, also to develop skills of scientific research work and to promote their use;

- to provide students with knowledge on application, analysis and design of telematics tools, combined with knowledge on physical processes and circuit technical solutions used in transport electronics;

- to provide comprehensive knowledge to students to develop skills and competence in accordance with the requirements defined by labor market for leading electronics engineers;

- to promote students' interest in social processes, to stimulate maturing of students into a positive, modern, responsible personalities able to act independently and make independent decisions;

- to ensure development of the study programme content, study process implementation, and scientific research work in accordance with changes in the field of quality management, international practice, scientific and pedagogical practice;

- to promote interest of students in further professional development by providing knowledge and skills for independent studies to increase the academic and professional qualifications.

Graduate of the study programme (**planned achievable results**):

- can manage transport computer networks, understand their internal processes;

- can design, develop, and operate electronic equipment and telematics systems. Perform its testing, analysis, operation modelling and improvements in accordance with requirements of the standards and develop the appropriate technical documentation;

- can utilize latest technologies and software for design and production processes of electronic equipment and systems;

- can participate in research projects and provide assistance in pedagogical work;

- can evaluate human resources and create a project working group, delegate work tasks and control their execution, present the progress and results of the project;

- is proficient at the concept level in latest telematics and electronic equipment manufacturing technologies, industry standards and technical norms;

- is proficient at the application level in signal processing, telecommunications theory, data coding and protection (cryptography) and training neural networks;

- is proficient at the application level in construction and design of telematics equipment, transport intelligent data transmission systems and sensor networks;

- is proficient at the application level in programming microcontrollers and microprocessors by using high-level languages.

Measurements of the study programme results are reflected in study results of students, employment of the graduates, feedback from employers, enhancement of international cooperation, increase of the number of projects, increase of the number of students involved in the research process, the approbation of the research results.

The title of the study programme, the obtained degree, objectives, tasks and achievable results are mutually linked and comply with modern young professionals needs and employers demands.

The programme with its activity promotes the keynote defined in the RTU Strategy for 2021 – 2025: ”High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities in the Baltic and Nordic region, which is acting based on a study system built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies”, and implements it in real life.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 states that ICT achievements and their widespread availability are a catalyst for change in the national economy, public administration, and society as a whole. The society knowledges, through the targeted use of ICT solutions, are transforming existing and creating new processes, business models, habits, and cultures in all areas of economy and life. The digital transformation is a key to productivity, economic growth, well-being of the individual and society. At the same time, according to Digital Economy and Society Index compiled by European Commission in 2018, the number of ICT specialists in Latvia accounted for was only 2.2% of all employees, which is significantly below the European Union (EU) average, or 3.7%. Industry research conducted by the Certus think tank in 2017 “Future goals, present directions. Latvia 2022” revealed, that Latvian IT industry needs up to 3,000 new graduates annually.

According to the Latvian Statistics Portal, a share of companies employing ICT / IT specialists has increased by 5% over the last 7 years and reached 73% in 2020. According to the Certus think tank industry study conducted in 2019, “Regional Competitiveness. Latvia's Competitiveness Report 2019”, salaries for ICT specialists in leading EU countries are about 30% above the national average, in Latvia this difference reaches 80%.

The telematics and transport electronics industry in Latvia and all around the world has been developing steadily in recent years, and the quality of transport telecommunications infrastructure is at a high level. The industry key performance indicators are growing and synergies with economy and other sectors of the economy will be important for telematics industry in the future. The economic and / or social justification of the study program is based on performed research of industry and employment of graduates.

The employment of graduates is an important indicator that shows the demand for study program prepared specialists in labor market. The employment of graduates of the study program “Transport Electronics and Telematics” is high, and the surveyed graduates make a career in acquired profession. Graduates mostly work in transport and telecommunications companies, IT companies, universities, scientific research institutions, industry manufacturing plants both in Latvia and abroad.

According to the study plan, students will have an internship in one of the industry's companies or organizations. Many employers post internship offers on the portal prakse.lv or send them directly to the management of study program. Upon completion of the internship, the employer sends feedback to the program director describing the results achieved. In general, employers have expressed a positive opinion about the preparation of students at the study program for internship and work. After the internship and Master’s Thesis are publicly presented, students often continue their work in the same companies where the internship took place.

Graduates of the study program can become consultants, engineering network designers, technicians, engineers, infrastructure specialists, telematics systems analysis and monitoring specialists, transport infrastructure solution development and implementation specialists. The knowledge acquired during the studies allows establishing of own company, taking the leading positions in private companies or State institutions, as well as to managing high-level engineering projects in the most demanded fields of modern technologies.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The professional master’s study programme “Transport electronics and telematics” is full-time programme studied in Latvian and in English. The analysis on implementation in English language hasn't been made, since there were no students in English groups during the review period. Still, several study courses of the study programme are implemented in other RTU study programmes in English. During the review period, an average of 14 students were studying in the programme. The dynamics of number of students is shown in Fig. 1.

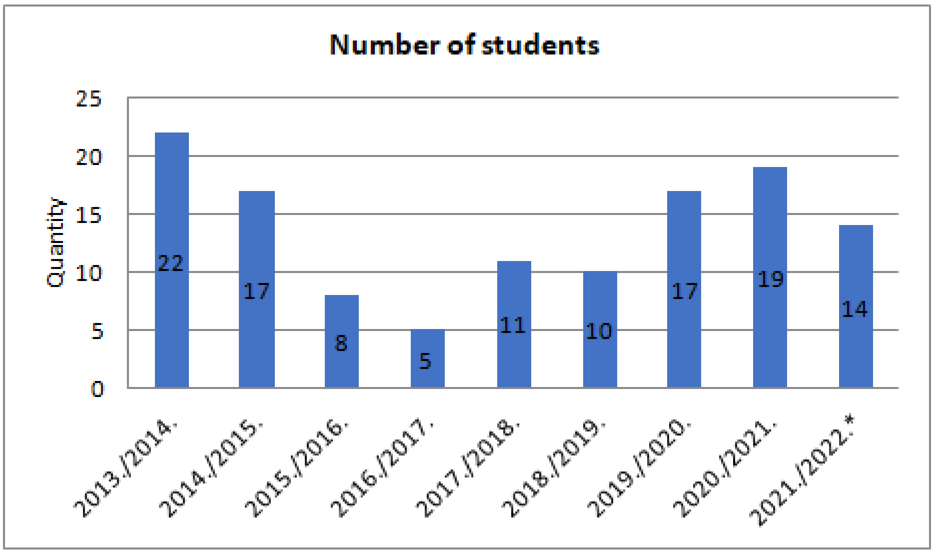


Fig. 1.: Dynamics of number of students of professional master's study program "Transport electronics and telematics" during the review period. *Data presented by 15.02.2022.

The total number of students enrolled in the professional master's programme experienced a fall from 2015/2016 to 2016/2017 during the review period. This fall had multiple causes:

- The academic bachelor's programme was discontinued, and its graduates were a large part of the professional master's study programme students;
- The number of "Transport electronics and telematics" bachelor's study programme graduates also decreased;
- The decrease of the number of students is caused by changes in modern labor market demands, demographic situation in Latvia. Students already obtain sufficient knowledge at the bachelor's study programme to successfully demonstrate themselves in the labor market.

Starting with 2018/2019 study year a steady increase in number of students is observed.

Every academic year has the dropouts of the students. The main reasons of such dropouts are academic failures and the own will of the students. Less common reason for dropouts are the students not resuming studies after academic leave or not commencing studies after matriculation. This can be explained by the fact that many of the students enrolled in the professional master's study programme also have a job at the same time, which creates difficulties during their study process. Not everyone is able to combine work with studies and students often choose to abandon their studies at the professional master's study programme. As a matter of fact, part of the students enrolled in master's study programme want to continue their careers in science and start doctoral studies after graduating the professional master's study programme.

There were 29 graduates in total for the study programme in time interval from 2013/2014 academic year to 2020/2021 academic year. The dynamics of graduates is displayed in figure below.

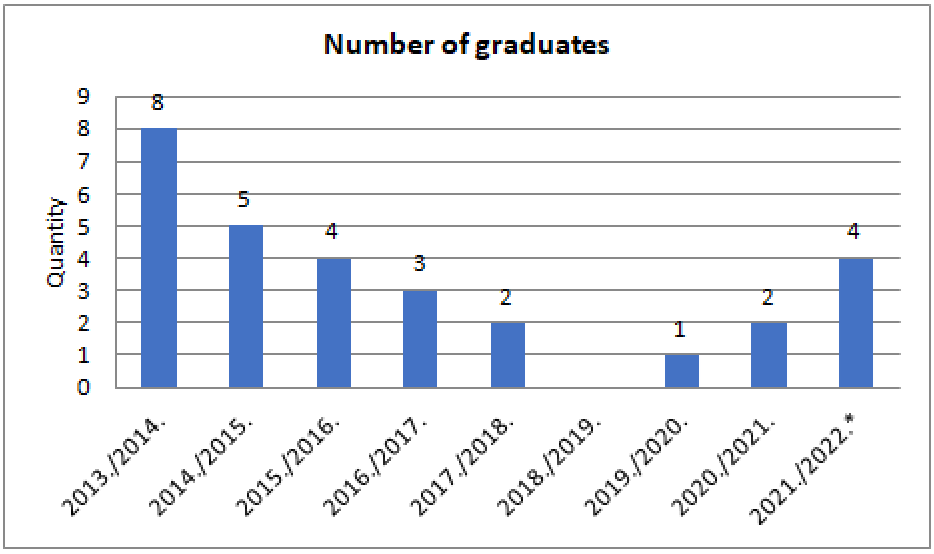


Fig. 2.: Number of students of the professional master's study program "Transport electronics and telematics" during the review period distributed by study year. *Data presented by 15.02.2022.

The dropouts rapidly decreased from 2021/2022 study year because of introduced improvements for study process and the study programme in general.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The study programme was specifically developed to combine several fields of science: telematics, transport electronics, computer science and cryptography. This ensures the training of wide profile professionals able to solve multi-functional telematics tasks and design, deploy and manage new electronic devices in transport telematic systems based on modern technologies. The amount of knowledge acquired during the studies and mastered practical skills meet the requirements of profession standard “Leading electronics engineer”. As the conclusion of the study programme, students develop and defend their master’s thesis works and afterwards are granted both the professional master’s degree and qualification of a leading electronics engineer. After completing their studies, graduates can continue their studies by enrolling to the doctoral studies programme.

The master's study programme has been accredited several times, the last accreditation was in 2013 (certificate No. 2020/80) and accreditation is valid through 30-th June 2023.

The place of implementation of the study programme is Riga. The type of implementation is full-time intramural studies (1,5 or 2 years). In the standard planning of RTU in each study year, there are 2 semesters, the length of each semester is 20 weeks - 16 study weeks and 4 session weeks.

The content of the study programme is updated according to the tendencies of the field, labour market and science development. Each year the study programme is improved, and the content thereof is updated, taking into account results of student surveys as well as recommendations from the employers. The vision of the professional master’s study programme “Transport electronics and telematics” is implemented on the basis of opinion of students, graduates, employers, and professional and non-government organisations, observing the direction stated in the development plans of Latvia and according to RTU mission and vision, objectives and tasks.

The competitiveness of the study programme is confirmed by the fact that all graduates are required in the labour market and are employed in their speciality just after graduation of studies.

The information included in the study courses is subordinate to the objective of the study programme - to acquire deeper knowledge and skills for the improvement of professional competence as well as to acquire skills for application of the obtained knowledge and skills in practical work. In the study programme, a connection is provided between the information included in the study courses, the achieved results, defined objectives, and methods as well as a connection to each study course with the objectives and achievable results of the study programme. The objective of the programme has been developed according to the needs of the national economy and society. The programme objectives are created so that students are educated according to requirements of the 7th Latvian qualification infrastructure level, as well as to promote the competitiveness of students in changeable social economic conditions and at the international labour market.

The study programme is implemented in the form of lectures and practical classes, reserving significant time for independent studies. The content of the study programme corresponds to requirements of the normative acts, and is created observing RTU Senate decision conditions “About common requirements for study programmes”.

The duration of the studies is 1,5 or 2 years, which are split in 3 or 4 study semesters, during which compulsory study courses, specialisation and free option study courses are acquired. In the end of studies, a master’s thesis shall be elaborated.

The volume of the study programme is 60 CP (90 ECTS) or 80 CP (120 ECTS). The study programme can be enrolled by applicants with academic or professional bachelor’s degree in engineering or equivalent education.

The volume of compulsory study programme courses is 23 CP (34,5 ECTS). The compulsory study courses develop knowledge and skills of the students and promotes knowledge and skills on scientific research methods and their application.

The compulsory elective (specialized) study courses (11 CP or 16,5 ECTS) are intended to enable future professionals to obtain in-depth knowledge in their selected specialization field.

The programme structure and all formal conditions correspond to state normative acts and to the requirements defined in RTU Senate decisions. If students have not acquired the requirements defined in Environmental Protection Law and Civil Protection Law in lower-level study programmes, students have an opportunity, within the framework of the master's study programme, in the part of free options courses to additionally choose study courses "Civil Defence" in the volume of 1 CP (ICA301) and "Environment and Climate Roadmap" 1CP (VAS038), as well as students of the programme branch in English, may choose Latvian language, study course "Latvian language for foreign students" in the volume of 1 CP (VLS711). The student concludes the study programme with internship at the field-related enterprise (6 CP for the 1-st implementation or 26 CP for the 2-nd implementation) and development of master's thesis work (20 CP or 30 ECTS).

Table 1: The study programme composition by study courses.

No	Code	Name	C.p. [1]	C.p. [2]
A		**Compulsory Study Courses**	**23.0**	**23.0**
1	TRT507	Systems Theory	4.0	4.0
2	TRL523	Communications System Models	3.0	3.0
3	RDE701	Telecommunications Theory (special course)	5.0	5.0
4	TRL342	Cryptography and Data Security Technologies	4.0	4.0
5	TRL446	Methods of Transport Real-Time System Performance Evalution	4.0	4.0
6	TRT306	Digital Signal Processing in Transport Telecommunications Systems	3.0	3.0
B		**Compulsory Elective Study Courses**	**11.0**	**11.0**
B1		**Field-Specific Study Courses**	**11.0**	**11.0**
1	TRT505	Global Navigation Satellite Systems	4.0	4.0
2	TRT500	Signal Digital Processing Algorithms in Communication Systems	2.0	2.0

3	TRL532	Computer Network Analysis and Design	4.0	4.0
4	TRL550	Network Operating Systems	3.0	3.0
5	RDE419	Fibre Optic Transmission Systems	5.0	5.0
6	RDE410	Design and Maintenance of Telecommunications Networks	4.0	4.0
7	RAE419	Telecommunications Marketing	2.0	2.0
8	REA407	Design Technologies	3.0	3.0
9	RTR802	Advanced Electromagnetic Simulations Methods and Software	4.0	4.0
10	REA703	Data Transmission in Wireless Sensor Networks	3.0	3.0
D		**Practical Placement**	**6.0**	**26.0**
1	TRT013	Practical Placement	6.0	
2	TRT010	Practical Placement		26.0
E		**Final Examination**	**20.0**	**20.0**
1	TRT002	Master Thesis	20.0	20.0
CP[*] credit points for study programme versions				

Lecture courses are generally theoretical, where research elements are embedded for students in the form of theses, research and other independent works. The orientation of practical classes is individual, where within the common topic each student elaborates an individual study project. Acquisition of knowledge, skills and competences in special subjects is monitored in the form of individual consultations. Attendance of practical classes is compulsory for all students during the whole period of studies.

During the study period of each study course students have to pass the planned tests, elaborate individual homework and study papers. Taking examinations is allowed only for those students, who have fulfilled all the requirements anticipated in the programme of the study subject. Results of examinations and tests are fixed in the RTU study management electronic database.

During the time of elaboration of the master's thesis interim checks for master's thesis elaboration progress are organized, where students present their progress of the research to the responsible teaching staff. The check includes:

- regular meetings with a scientific advisor of a master's thesis;
- the last second-year students at least one time per month report about their progress in the elaboration of the master's thesis.

At the same time, it is necessary to underline that all teaching staff involved in the implementation of the study programme perform research work, which is reflected in publications and participation in the projects.

When implementing the study programme, its objective "to prepare experts, who are able to think systematically, analyse, develop, introduce new engineering technical solutions. In addition, to develop the ability of students to perform scientific work, participate in local and international projects and continue studies in the doctoral study programme.", corresponds to the level 7 of the European Qualification Framework (EQF) and Latvian Qualification Framework (LKF).

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The study programme was specifically developed to combine several fields of science: telematics, transport electronics, computer science and cryptography. This ensures the training of wide profile professionals able to solve multi-functional telematics tasks and design, deploy and manage new electronic devices in transport telematic systems based on modern technologies. The aim of the study programme is to train specialists of internationally recognized level with a professional master's degree trained to perform design and technical operation works for transport electronics and telematics systems in the following fields: transport radio systems, transport telecommunications, transport computer systems and networks, aviation communication systems, railway transport communication and information systems. To teach professionals skills of analytical thinking, modelling, developing, implementing, and managing new engineering solutions. In addition, to develop ability of the students conduct a research and experimental work, participate in local and international projects, and continue their doctoral studies.

Graduates of the study programmes can apply their skills both in Latvian and international enterprises working in the field of information technologies. Since the creation of the study programme almost all its graduates were successful in finding jobs in the public sector, municipality, or commercial sector, which is a good indicator of the study programme competitiveness. Many graduates work in leading positions of state administration, ministries, and other institutions.

Practical and theoretical studies have an important role in study programme. Students develop their final thesis work in accordance with their selected topics determined by their supervisors (faculty or industry representative) and coordinated with Head of the responsible RTU institution. The thesis work reflects author's original studies, development, and design results, supplementing a qualitative contribution to the development of a specific device or system, as well as the industry field as a whole. The task of the thesis work is to develop the structure of defined transport telematics system, analyze its parameters and conduct experimental research or simulation of algorithms. The master's thesis work must be publicly defended in front of a State Examination Commission. The commission operates in accordance with regulations approved by the University Senate and consists of both university academic staff and industry professionals.

It should be emphasized, that significant changes were introduced to the study programme, which are fully consistent and comply with development trends of the corresponding science fields. Therefore, it can be argued that the content of the study programme, academic staff involved in its implementation and the essence of improvements are fully relevant to the trends and demands of the corresponding science and industry development trends.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study programme is implemented by joining theoretical and practical knowledge and skills in the form of lectures, seminars and practical activities. In the study programme, the study courses and elaboration of the graduation paper are proportionally distributed by semesters so that they append each other by providing students acquisition of the targeted knowledge and skills. In general, the study programme and each semester plan are created by focusing on the acquisition and strengthening of theoretical and professional skills of each student by working individually or in a team.

Assessment of study results takes place according to the Regulation for assessment of learning outcomes (only in Latvian) and the Regulation for final examinations at Riga Technical University (only in Latvian).

The teaching staff responsible for the study courses, according to course content and programme specification, as well as student needs, choose the structuring, teaching and evaluation methods of the study courses. There are courses and seminars organized for the academic staff about the newest pedagogical methods, as well as attendance to qualification raising and upgrading courses is promoted within the Faculty, RTU and worldwide. RTU academic excellence centre organizes academic staff training events at the university level.

The study program is implemented in Latvian and English and provides for full-time studies. When implementing the content of the program, the requirements formulated in regulatory acts and the basic principles of study process organization determined by RTU are taken into account, as well as all study course requirements are met. The course descriptions of the study program define a set of relevant knowledge, skills and competencies and their evaluation system. The intended study results are defined, for the achievement of which credit points are awarded. The full-time type of study corresponds to 40 CP in the academic year. In master's studies, 40% of the workload is contact hours and 60% is independent work.

The methods used in the study programme promote the acquisition of objectives and results of the study courses and the programme. In improving the study process students can express their wishes to the teaching staff of the certain study course, the head of the group, the programme director or with the help of student self-government, representatives of which are members of the Council of the Faculty of Electronics and Telecommunications (FET), RTU Senate and RTU Senate commission as well as members of RTU Academic council. FET make relationships with students on the basis of principles of mutual trust, respect and integrity. Students are provided with an opportunity to influence their own process of studies, implement their own autonomy, to submit feedback on the process of studies by combining it with their own professional growth interests. A large role in the provision of linkage among students, teaching staff and programme administration is given to the FET student self-government, which actively takes part in all the mentioned processes and performs an annual assessment of the teaching staff.

When starting the study course, the teaching staff inform students about the requirements for the acquisition of the study course and introduces to students the assessment criteria of the study course. All information is published in the electronic environment of study courses ORTUS. Once per semester students assess the work of the teaching staff in the ORTUS environment by answering a questionnaire. This includes assessment of the advancement of studies, individual tasks, acquired skills, relationships and cooperation of a teacher with students. Questionnaires are anonymous.

In the study programme, complete implementation of study results is provided. The study results are formulated both at the study programme level and at the study course level. The achievable learning outcomes are discussed with students at the beginning of each study course, and also such information is available in the ORTUS environment. A linkage is provided between the achievable results of the study programme and those of the study courses. According to the achievable results of the study programme, content, and volume in credit points of study courses are created, and in its turn, according to the achievable results of the study course, topics and volume thereof are created. In all study courses, the achievable results are verified with the corresponding assessment methods.

During the implementation process, the study programme is appended and updated based on science development, labour market research and consultations with employers and practising experts. Recommendations received from graduates, students and teaching staff of the university are significant for the improvement of the study process.

Many various study methods are used in the pedagogical process: individual and group work, individual and group consultations, presentation of results, project work, tests, verbal and written examinations, practical laboratory works, discussions etc. At the beginning of each study course, the lecturer explains to the students the study course goal, determines the knowledge level of the students and their former experience. To the extent possible, the teaching staff and students agree on the studies process, methods, assessment etc. When teaching methods are combined, their suitability to different groups of students is maintained, so that the students with different needs can acquire knowledge and skills in the most suitable way for them.

During the studies, the student-centered approach is adopted. In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific master's thesis research, and the choice of a particular major, as well as in group work, which to a large extent also allows the manifestation of organizational skills, leadership qualities and other transdisciplinary skills.

A significant role is given to the independent learning of students. Description of independent work is included in the description of the study course as a compulsory component. The ability of students to learn independently is purposefully developed in all study courses. Students acquire practical and research work skills by regular use of literature and Internet resources, including international scientific databases, which are available at RTU library with electronic access to the ORTUS environment, in order to successfully elaborate research study papers.

The centre of RTU structural units, including staff, science, international relations, studies and also Academic excellence regularly inform the staff about opportunities to improve their competencies in scientific research and methodological and digital skills in the field of general competencies and specific professional activity. In the ORTUS environment information about the scientific activity of the academic staff is stored. To perform pedagogical work at a high level, methodological seminars are organised for RTU teaching staff about opportunities for the application of various learning methods, experiences and best practices.

Academic staff of the programme regularly improve the content of studies by introducing to the study process new, innovative study organisation and learning methods, the main objective is to teach how to learn, look for information, use various sources of information, discuss, work together with others, make decisions and take responsibility. Cooperation here is done in both directions, student-student and teacher-student. International experience is integrated into the study process.

Analyzing the study implementation and results in evaluation methods used in the study program, it must be concluded that the principles of student-centered education are consistently observed:

- the student contingent and the diversity of their needs are taken into account and respected when creating suitable learning paths;
- different ways of implementing the study program have been used;
- guided by the student’s abilities and needs, the teaching staff uses diverse pedagogical methods and encourages the student's desire for independence, while at the same time providing the teacher's guidance and support;
- the conduct of the study process in the study program promotes mutual respect in the relationship between students and teaching staff, as the principle of democracy is observed and the administration of the study program takes into account the opinion of students.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Following mastering of theoretical study courses, students extend and consolidate professional knowledge in practice. The goal of internship is to provide students with practical activity experience required for obtaining professional qualification in one of the industry's companies or organizations. During the internship, students get acquainted with the company structure and its operation organization, as well as economic indicators of the undertaking. Students are provided with an opportunity to master the latest scientific and innovative technical solutions in the field of transport electronics and telematics. Depending on the program version (60 CP or 80 CP) the following study courses are provided: TRT013 Internship or TRT010 Internship. For students who have previously completed the professional Bachelor study program it is only necessary to attend the TRT013 Internship to enhance competence and develop the skills necessary to design, repair, and upgrade transport electronic and telematic systems, as well as to develop skills to test and measure electronic circuit parameters. For students who have previously didn't complete the internship in Bachelor study program it is necessary to attend the TRT010 Internship to provide the student with the practical experience of working at a profile company or institution required to obtain a professional master's qualification in accordance with the professional master's study programme. Tasks of the TRT010 internship: to acquaint students with the latest scientific and innovative technical solutions; to allow students to obtain competence in labour protection, civil protection, labour safety, environmental protection and to get acquainted with technical and organizational solutions; to supplement and foster the knowledge acquired during theoretical studies and provide an opportunity to acquire practical leading engineering skills; to develop students' skills to summarize and systematize information. Students can utilize transport electronics and telematics systems, are able to independently learn new technologies and evaluate possible solutions for their implementation, know transport telematic systems, wireless telecommunication technologies, are able to apply scientific research methods during the work as a leading electronic engineers after Internship.

The necessity of the additional research internship is provided by the requirements of the new professional standard of the Leading electronics engineer, according to which the graduates of the professional program have to be able to perform scientific research work: perform research of electronic devices, systems, and relevant materials, processes and technologies (to perform the analysis of the issue status, to substantiate the selection of the research method, to perform computer simulation and experiments); independently define and research complicated scientific issues; supervise research work; prepare reports on research results in the industry and professional activity; integrate the knowledge of various fields by contributing to the development of new knowledge, methods of research or professional operations.

The Internship is organised in compliance with the Senate decision on the Procedure of the organisation of the Internship at RTU (only in Latvian). It is mentioned there, that the internship coordinator in the corresponding structural unit assists students in finding an internship placement. If additional assistance is needed, it is possible to contact the Division of Career Support and Services where a career consultant and a project manager helps students to find internship placements and to contact them, as well as implement various events to contribute to development of career management skills, which can ensure successful results in the internship process. Once a year, the Division of Career Support and Services organises the RTU Career Day, where students can meet company representatives and speak about future opportunities. See more details about the event and participants of preceding years: https://www.rtu.lv/lv/studentuserviss/karjeras-centrs-ssc/karjeras-diena. In 2021, due to the pandemic, the event took place in a virtual environment.

An additional resource developed since 2015 is a website where companies are invited to post their vacancies interesting for RTU students (https://ekarjera.rtu.lv/). Students can connect with the university username and follow current internships and employment opportunities in their industry.

The RTU Development Fund also supports promoting practical skills (https://www.rtu.lv/lv/attistibasfonds). During the year, several hundreds of competitions to improve practical skills are offered and organised in cooperation with companies and provide an opportunity for students to learn practical skills. The university enters into cooperation agreements with companies and organizations every year (see the draft of the agreement in annexed file 37 in the List of Internal Regulations), where it is agreed to provide internships for students.

Internship for foreign students is organized similar to internship for local students. Additional support is provided by International Cooperation and Foreign Students Department (ICFSD), that is involved (if necessary) in conversation between students and potential internship employers for clarification of formal requirements.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The master’s thesis work (20 CP or 30 ECTS) development and defense concludes the studies of professional master’s study programme. Master’s thesis work is a comprehensive and in-depth research demonstrating the competence of the master’s candidate in accordance with the 7-th LKI level of the profession standard. The master’s thesis work is developed in accordance with the student’s selected topic determined by his supervisor (faculty or industry representative) and coordinated with Head of the responsible RTU institution. The thesis work reflects author’s original studies, development, and design results, supplementing a qualitative contribution to the development of a specific device or system, as well as the industry field as a whole.

The task of the thesis work is to develop the structure of defined transport telematics system, analyze its parameters and conduct experimental research or simulation of algorithms. The master’s thesis work must be publicly defended in front of a State Examination Commission. The commission operates in accordance with regulations approved by the University Senate and consists of both university academic staff and industry professionals.

The goal of the master’s thesis work is to develop the ability of students to apply theoretical knowledge, professional skills and experience obtained during their studies in the field of transport electronics and telematics. The tasks of master’s thesis work are:

- to develop the capacity to assess different transport electronic systems, analyze different types of data transmission and processing, evaluate electronic circuits and their applications;
- to develop skills of conducting practical research and utilize mathematical modelling methods for testing designed algorithms;
- to develop students’ ability to formulated reasoned conclusions and develop realistic and reasonable proposals, present them and express personal professional opinion.

Examples of “Transport electronics and telematics” study programme master’s thesis works with a project part are provided below.

2013/2014 study year

- Evaluation of characteristics of civil and military radio electronic equipment and possibilities of use in military aerodromes
- Noise Immunity analysis of Communications channels in SIMULINK
- 4G Mobile Data Network Evaluation, Analysis and Recommendation Development to Increase Efficiency
- Stand Development for Software Defined Networking Research
- Aircraft Navigation Information Complex Processing
- 4G Network Performance Analysis and Recommendation Development for Mobile Client Using
- Analysis of Noise-Immunity for Trellis Coded Modulation with QAM16 Constellation
- Development of electric car control unit
- Research of railway noise assessment methods
- Complex Navigation System Based on Satellite and INS Systems Development

2014/2015 study year

- Applying Fuzzy Logic Algorithm to Temperature Regulating Devices
- Mobile Communication Jammer Analysis
- Development of Multifunctional Real-Time Tester on FPGA Base
- Informative training system for operating system "Ubuntu"
- Modern VDSL Technology Solutions and Comparison with ADSL

2015/2016 study year

- Two Stages Vehicular Network Performances Evaluation for Many Workstation in One Access Point Environment
- Heterogeneous Vehicular Network Updating and New Developed Network Research
- Development of the Database for Vehicle Location Data Storage
- Development and Research of Temporal Database Models

2016/2017 study year

- Mobile Wireless Network Throughput Research in OMNeT++ Environment
- Data Base for GPS Receiver Testing Results
- LTE - WIFI Network Data Flow Testing and Analysis of Results
- Evaluation of Microwave Communication System Parameters in the 38 GHz Range

2017/2018 study year

- Development of Program for Transport Traffic Analysis Using Computer Vision Solutions
- Measurement and Control System Development fo Universal Helicopters Gearbox Test Stand

2019/2020 study year

- C-V2X Communication Performance Analysis Using LTEV2VSIM Simulation in MATLAB

2020/2021 study year

- Analysis of implementation of distributed key generation protocols
- Network connection type impact on the accuracy of network traffic classification with supervised machine learning algorithms

The results of the students’ final examinations are annually discussed at the RTU FET TI TTES group meetings for master’s study programme “Transport electronics and telematics”. The results are also summarized and evaluated by management of the study programme, and they can be used for further improvements of the study process. For the review period from 2013/2014 to 2020/2021, the average grade of the final master's thesis works on the 10-points scale is 8,16.

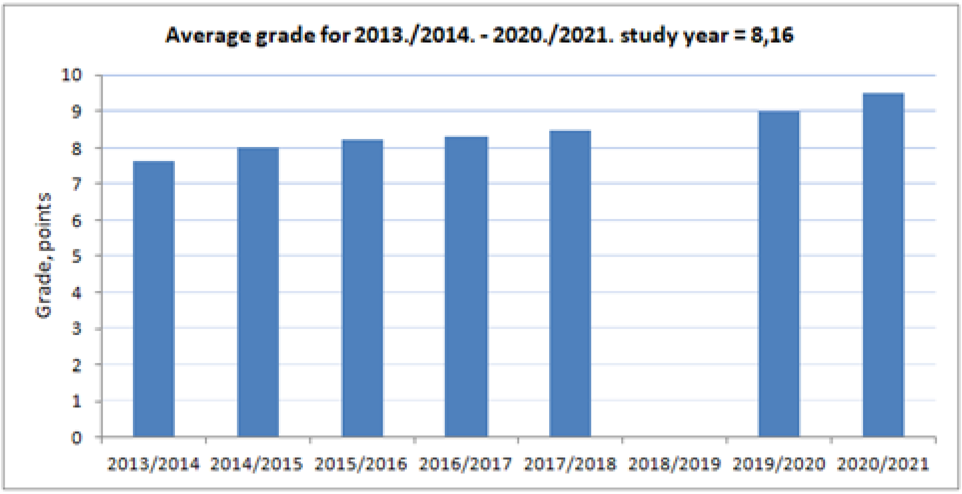


Fig. 3.: The average grade of final thesis works for professional master's study programme "Transport electronics and telematics" over duration of the review period.

The State examination commission of RTU FET TI TTES group particularly appreciates the participation of students at scientific-research activities (conferences, publications) by awarding higher grades.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU have decentralized budget, therefore each structural unit has separate budget. The budget generally means a plan of incomes and expenses for a certain time period, work, event or a function. RTU incomes and expenses are administrated by the principles approved by the Senate or by the vice-rector for finances with assigned powers. Income can be of such categories, which are allocated to a structural unit for a work, for which it is responsible, for example, provision of consultations, organisation of trainings, and which are allocated to a structural unit as the result of calculations, on the basis of the volume of the planned works and/or indicators obtained in the previous periods (i.e., science support). In RTU for each structural unit, director remote access to operational financial information about the structural unit budget is provided, including the information about the planned volume of works and the corresponding financing in the next periods for implementation of the study programme and the study courses. At the beginning of each finance or budget year, the structural unit director plans the work of the structural unit, including salaries of the academic staff subordinated to the certain structural unit director and elaborating the procurement plan for the next year according to the provision of the study programme or the study course activities and development etc.

For the implementation of the study programme and achievement of the learning outcomes each year material and technical provision is assessed as well as the study and science provision base including printed and digital editions.

According to the volume of the programme financing, regular renewal and improvement of resources and software are performed.

In the implementation of the programme such material resource base is used:

- rooms (for both lectures and practical classes);
- modelling computer laboratories;
- experimental laboratories;
- methodological cabinet;
- RTU Scientific library book and periodic material storage.

There are other RTU infrastructure elements available for the needs of students and instructors - canteens and cafés, copying rooms, student hostels, RTU sport and recreation centres, swimming pools etc. In RTU rooms there are trading automates installed for buying various drinks and snacks, and drinking water is available free of charge. Information storages are regularly renewed and appended with regular and periodic leading world professional and scientific editions and books in the field.

The University library is of major importance for the implementation of the methodological and informative provision of the student. RTU Scientific library is the official state-level library, which obtained its status as a result of accreditation. The library provides all the necessary information for the RTU study process and research activities and performs library, bibliographic and information services for RTU students, academic staff, and employees. In the library collection, there are 1.4 million printed documents and e-resources in the databases corresponding to the RTU fields. Students have access to the databases, for which the RTU library is subscribed:

- **EBSCOHOST eBook Academic Collection** - eBook Academic Collection database contains ~202 200 books in various science fields: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.
- **IEEE Xplore Digital Library (IEEE/IET Electronic Library)** - IEEE Xplore Digital Library is the most extensive database packet, where all IEEE/IET full-text journals, conference materials, collections of scientific papers are available.
- **E-journal and e-book search** - with the help of SFX software it is possible to precisely define the location of an e-resource (e-journal, e-book) in the RTU Scientific Library subscribed and free access databases.
- **SpringerLink** database e-books, available are 18 500 e-books (issued within 2014 -2020) in the fields: of computer sciences; engineering sciences.
- **Web of Science** is the leading research platform of electronic resources. The unified platform provides an integrated approach for high-quality literature, it unites the search for information in bibliographic (also citation index) databases, helps find the newest and the most important scientific publications in the journals with high influence factor, collections of conference proceedings etc., as well as show citation of scientific publications.
- **Latvian standard database** content: Latvian national standards (LVS); European standards adapted to Latvian standard status (EN); International standards adapted to Latvian standard status (ISO); annexes to standards: amendments and corrections. Thematic arrangement corresponds to the internationally accepted International Classification for Standards (ICS). Standards can be searched by number and can be read.
- **EBSCOHOST -** EBSCO databases comprise periodical publications in computer sciences,

engineering sciences, humanitarian and social sciences, economics, business, medicine and other fields.

- **ProQuest Ebook Central** (earlier Ebrary) database provides an opportunity to read scientific books in electronic format. In the ProQuest Ebook Central platform, a collection of electronic books «Academic Complete» is available, where about 200 000 e-books in English in PDF format are found, which were published by the world-leading scientific editions – Elsevier, Wiley, Springer, Oxford Press, Emerald etc.
- **ScienceDirect** is one of the largest databases of scientific, technical and medical articles in the world, which comprises full texts of Elsevier Science edition journals.
- **SCOPUS** (publisher Elsevier) – a bibliographic citation database of scientific literature, created by scientists for fast acquisition of information.
- **ACM Digital Library** offers high-quality publications in computer science – computer security, computer graphics, acquisition of information, mobile technologies, software development etc.
- **WILEY Online Library** database offers a packet of full text scientific reviewed journals „Full Collection”.
- **Letonika** is a Latvian information and translation system on the Internet, the main objective thereof is to provide systematized encyclopaedic data and information on translation, by creating new, knowing the existing and maintaining digital resources about Latvia.
- **Learning material repository – MERLOT** The largest free access storage of learning materials in the world, which contains more than 28 000 materials and an opportunity to attach own learning materials. Here are also links to more than 500 other learning material repositories, creating unlimited opportunities for online browsing of learning material.

RTU IT provides academic and methodological work: creates and renews study course descriptions, provides instruction of the corresponding courses (including practical, laboratory and seminars classes), conduction of graduation papers and the defence thereof and performs other activities related to academic, methodological and scientific work.

The professional master’s study programme “Transport electronics and telematics” is implemented at FET building located at Āzenes street 12, in Riga. An environment matching modern requirements is located here. All audiences for the study process are equipped with multimedia devices – computers with Internet access, speakers, projectors. Thus, it is possible to ensure modern study process. Students of the “Transport electronics and telematics” study programme conduct their scientific research for master’s thesis works and laboratory works in one of the following RTU TI laboratories and computer classes:

- **Laboratory of Transport's Network Performance Evaluation and Radio Navigation**

In this laboratory, students study the courses of the master's program: TRL446 "Methods of Transport Real-Time System Performance Evaluation", TRT505 " Global Navigation Satellite Systems " and TRL342 " Cryptography and Data Security Technologies". Thanks to support of SIA “Mikrotīkls” in 2021, the material and technical base of the laboratory has been modernized. A powerful computer for server function role, 2 interactive whiteboards and 7 laptops have been purchased. Special gratitude to SIA "Mikrotīkls" for providing additional equipment (routers, racks, connections, mounts, etc.), which allows performing various data transmission experiments and demonstrations. The laboratory is equipped with all necessary equipment to develop transport telematic systems and perform transport network performance evaluation, modeling and analysis: Global computer network emulator Candela Technolgies WAN Emulator; Computer Network Traffic Generator Candela Technologies Traffic Generator; Computer Network Traffic Analyzer Agilent 76801A Distributed Network Analyzer; Mikrotik RouterBOARDS hAPac (IEEE 802.11ac standard); Routers Cisco 1841; Hewlett Packard Wireless Network Controller MSM720 and Access Points

MSM640; Multi-channel GPS / SBAS Simulator; GNSS 72 channel GPS + GLONASS receiver, 1cm RTK accuracy.

- **Laboratory of Transport Electronics**

In this laboratory, students study master's courses TRT306 "Digital Signal Processing in Transport Telecommunications Systems", TRT500 "Signal Digital Processing Algorithms in Communication Systems" and RDE701 Telecommunications Theory (special course)”. In the laboratory, students conduct research on electronic vehicle control systems. Xilinx XC3S500E Spartan-3E FPGA boards are available for this purpose, which can be controlled and programmed from a personal computer. Digital oscilloscopes with 4 channels are used to control the operation of the devices and to inspect time diagrams of input / output signals, as well as to save them for later use in reports. During the practical work, an arbitrary shape signal generator is also used to generate the input signal for digital circuits.

- **Photonics laboratory**

In this laboratory, students acquire master’s study programme courses: “Fibre Optic Transmission Systems” (RDE419), "Digital Optical Communication Systems" (RDE713), and “Physics of Optical Information Processing” (RDE417). These are the study subjects, which give students basic knowledge in the field of innovative Photonics. In the laboratory replacement of the existing training devices (a part of them has been used since the beginning of the 90s) and components have been done with the devices and components, which are more modern, more related to the field and students and more attractive. The laboratory provides an opportunity for students to obtain an understanding of optical methods of information processing and administration, about development tendencies and prospective thereof, as well as an opportunity to deeper study those sections of Photonics, which form the base of optical processing and transmission of information. Renewal of the laboratory equipment gives an opportunity to involve students and young scientists in research work by implementing various solutions of signal optical processing devices, including applications, which are compatible with radio over fibre systems, 5G, IoT, sensor technologies and not only.

- **A simulator classroom for communication systems and telecommunication networks**

The computer classroom is equipped with 16 computers with various simulation, computation, programming and designing software (Seamcat, HTZ Communication, VPI Photonics, OptSim for Optical Communication, Matlab, Autocad, Java, Python etc). In this computer classroom students acquire master’s study courses: RDE410 “Design and Maintenance of Telecommunications Networks”, TRL532 “Computer Network Analysis and Design”.

- **Laboratory of the Internet of Things (IoT)**

This Laboratory of the Internet of Things (IoT) has been established in cooperation with the enterprise Siemens Latvia and is mostly designed for various industrial IoT solutions and the creation of sensor networks. In the laboratory, there are various devices, for example, programmable logic controllers (LOGO, SIMATIC S7 1200), micro controllers (Arduino, ESP), Bluetooth, ZigBee, LoRa, NrF 24, 4G radio receivers, IP network gateways (Simatic IOT 2040, Raspberry PI) as well as various training sets. Here students can elaborate on master’s thesis work research, which is connected with the collection of various electronic sensor data and sending them within the IP network for data aggregation and processing students and scientists have access to the IoT cloud platform Siemens MindSphere.

During the period 2013-2022 for the needs of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” RTU

TI has acquired infrastructure for laboratories, practical classes (e.g. computer programs for modelling) and lectures (e.g. scientific literature, databases of scientific articles), computer hardware (monitors, computers, presentation lasers), laboratory equipment (ELQ-2 analyzer, GDS-1052-U oscilloscope, TLP-3c transmission error rate meter, PicoScope virtual tool, sensor signal processing and analysis devices (HW Group): Poseidon 2, STE2, WLD2, sensors (temperature, air humidity, light intensity), detectors (door contact, light flow, motion, smoke, vibration, power), Amplifi access points with amplifying antennas, NonBeam M5 microwave antennas, training kits for voice data transmission and plastic optical fiber and free space optics, etc., 11 personal computers (Capital NEO GX33 MT, LCD monitors, keyboards, mouses), microcontroller training kits (12 pcs. Arduino UNO starter kit and IoT trainer kit).

For additional convenience for RTU students, teaching staff and employees, RTU rents *Microsoft Windows, Microsoft Office* and specialised software, which provides all users with the access to the newest *Microsoft* software, and also RTU students, for learning purposes, can use RTU provided licenses for Windows operating systems and products of *Microsoft Office*. All users have access to the *Microsoft Office 365* cloud platform with one terabyte of space for data storage and access to additional shared and efficient tools (*Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook*, etc.). RTU students, teaching staff and employers have access to university e-mail services.

On all RTU premises students and teaching staff have opportunities to use a free Wi-Fi Internet access point network. The teaching staff are provided with a computer and a well-equipped workplace in classrooms - working rooms.

For all study courses, methodological materials are regularly updated and uploaded by the teaching staff in the ORTUS environment.

The study process is organized mainly by academic staff of RTU FET Telecommunications Institute (13100). In addition, for professional specialization part (B1 part) and the humanitarian and social study course part (B2 part) the following institutions are involved:

- Electronic Hardware Academic Department
- The Academic Department of Fundamentals of Electronics

All users have access to the centralised portal ORTUS, which serves as a digital gateway uniting the data from all RTU information system components, and provides users with an easy and simple user interface and easy access to the catalogues of all services in one place.

To provide effective implementation of the study process Moodle e-Learning environment is used, where all the information is prepared in an automated way (study courses, users, groups, access rights etc.). In such a system student-teacher communication is provided. The teaching staff upload to the system various electronic materials, knowledge checking tests, homework, information about each study course etc. In the ORTUS portal, students can view their financial information, and request documents (references, academic transcripts or records, copies of agreements etc.).

For effective resource management and planning of studies digitalisation of schedules and room planning is done (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or teaching staff can check their schedule, where it is possible to see the place of venue, the name of the teaching staff, classroom number, the name of the lecture and the type of classroom activity. For additional user convenience, the system significantly facilitates room planning and schedule preparation process and also optimizes the efficiency of classroom occupancy.

For effective administrative work, electronic staff management and record-keeping systems are used, which provide record-keeping and staff document handling in RTU (https://docs.rtu.lv/). The functionality of electronic reconciliation and signature of documents is introduced thus decreasing the handling amount of printed documents and significantly increasing the speed of document handling. From the autumn 2019 electronic signature of study, agreements are provided for the students when being enrolled. From 2016 RTU graduates can receive transcripts of records in the form of an electronically signed document.

For the provision of quality, a digital student survey system is used, which helps in controlling the quality of study courses and study programme implementation each semester. On the basis of the quality control results, regular measures for improvement of the study programme and processes are performed.

The total assessment of the resources is reflected in the data provided in part II Section3, criteria 3.1.-3.3. of the Study Field Report.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The source of funding for the professional master’s study programme “Transport electronics and telematics” is both the State budget and individual tuition fees.

For 2021/2022 study year admission there were 7 available places funded by the State. The tuition fee for the study programme is 1975 EUR per semester.

Table 2: Information on study programme financial resources is presented below:

Study year	Grant for the programme, EUR	Tuition fee for the programme, EUR		Total financing for the programme, EUR	Financing of one state budget seat, EUR
		Tuition fee for local students, EUR	Tuition fee for international students, EUR		

2013./2014.	73 963,00	-	-	73 963,00	5 799,00
2014./2015.	67 451,33	-	-	67 451,33	5 799,03
2015./2016.	43 310,12	-	-	43 310,12	5 799,03
2016./2017.	20 316,08	-	-	20 316,08	5 799,03
2017./2018.	19 020,35	-	-	19 020,35	6 060,99
2018./2019.	23 780,89	-	-	23 780,89	6 344,52
2019./2020.	28 525,83	-	-	28 525,83	6 607,56
2020./2021.	64 514,79	-	-	64 514,79	6 694,22

The funding for one study place has increased in 2020/2021 study year by 15% in comparison with 2013/2014 study year.

RTU's funding from the state basic budget consists of study base funding corresponding to the list of study programs and the number of students, which consists of funds for utility payments, taxes, infrastructure maintenance (including providing data to the Register of Students and Graduates), the purchase of equipment and equipment, and staff salaries, as well as funding for scientific activity and business trips.

The financial resources of the study program "Transport electronics and telematics" are partly sufficient for the implementation of the study program and their use is regularly controlled both by the administration and the financial vice-rector of RTU.

The available funding is mainly used to pay for the work of teaching staff, as well as to maintain and improve the teaching infrastructure. The implementing structural unit – the Institute of Telecommunications is responsible for specific financing tasks. Funding decisions are made at the department, institute or faculty level. Significant efforts are devoted to enriching the skills and abilities of teaching staff, therefore part of the funding is devoted to paying for various courses, seminars, business trips, as well as academic vacations. Also, the investment for the addition of equipment is systematically planned.

The information about the distribution of the funding among cost items is given in the self-assessment report of the study field in the annex “Distribution of funding among the cost items”

Information about the minimal number of students in the programme is given in the self-assessment report of the study field in the annex “About_the_minimal_number_of_students_in_study_programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and

the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualification of the teaching staff involved into implementation of the study programme complies with conditions and requirements of regulations. All responsible teaching staff members involved into implementation of the study programme have doctor's degree of science. All lecturers reading lectures in study courses have at least master's degrees, while practical and laboratory classes are mostly supervised by teaching staff members with master's degrees, but in some cases industry professionals with necessary practical experience are also invited.

The study programme implementation involves teaching staff of different levels and professional qualifications to fulfill the study courses of the study programme in a highest possible quality. There are total of 4 professors, 2 associate professors, 4 docents and 1 senior researcher involved into implementation of master's study programme.

The qualification of the teaching stuff applied for the study courses complies with requirements of study programme implementation. Highly qualified scientists and industry professionals participate in implementation of the study programme. The policy of recruitment, renewal and professional development of the academic staff is based on the regular involvement of master's study programme students, master's degree graduates and doctoral study programme students in the process of studies.

The qualification of the teaching staff involved into implementation of the study programme complies with conditions and requirements of regulations and provides achievement of the goals, tasks and results for each study course and the study programme in general. CVs of all responsible teaching staff members is provided in annex (see CVs of teaching staff – P20). RTU FET TI is responsible for the study programme. Information about RTU FET TI professors and associate professors actively involved into implementation and refinement of the study programme is provided below:

Vjačeslavs Bobrovs, Dr.sc.ing., professor, senior researcher, RTU, Faculty of Electronics and Telecommunications (FET), Telecommunications Institute, Transmission Systems Group: dean of FET. Professional experience: academic and scientific work experience of more than 15 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics, wavelength division multiplexing, passive and active optical networks, microwave telecommunication systems, mobile networks, wireless communication systems), natural sciences - Physics and Astronomy (optical processing physics, conference, optical waveguides, lasers, optical elements, fibre optical elements), engineering sciences and technologies – nanotechnology (nanoparticles, nanophotonics, nano aerials, metaphotonics, anapole state, anapole dynamics, integrated photonics). Director of the academic bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering", the academic master's study programme "Telecommunication Technologies and Networks Management", and the academic doctoral study programme "Telecommunications". Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, RTU Scientific Council, member of the Senate and Constitution Board, member of the RTU Electronics, Information and Communication Technologies, Computer Sciences and Information Science. Member of IEEE since 2012. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 13, co-author for 17 patents. Researcher or project manager in more than 15 projects in total. More than 80 bachelor papers, 85 master's papers, and 7 promotion works are advised and successfully defended. Participated in ERASMUS academic staff exchange. Regularly participates in professional training and academic seminars.

Ernests Pētersons, Dr.sc.ing., professor, Telematics and Transport Electronic Systems group of RTU FET Telecommunications Institute. Directions of scientific research: the main direction of research relates to theoretical and experimental study of traffic in transport wireless networks and with practical application thereof for improving network performance. Published >60 scientific articles (indexed SCOPUS), 5 monographs, H-index 4. More than 40 bachelor and master theses, 7 promotion papers are advised, conducts the study courses of Telematics and Transport Electronic Systems group of RTU Faculty of Electronics and Telecommunications Telecommunication Institute "Computer Networks", "Information Compression and Encoding Theory", "Cryptography and Data Security Technologies", "Network Analysis and Design", "Communication in Transport Intellectual Systems", "Real-Time Communication Systems", "Communication System Models". Active participation in other educational institutions in Latvia by reviewing promotion papers, including the LU Institute of Mathematics and Computer Science. In total, by working in various state educational institutions in Latvia he prepared 22 highly qualified specialists with a doctor's degrees. The experience of project manager and executor in various state and internationally financed scientific research projects – RTU scientific research platform project, State research programme and ESF projects. Practical scientific cooperation within the last years has been with the prof. Aļģimantas Kajackas from Vilnius Technical University and the prof. Vladimir Vishnevsky from the Management Problem Institute of the Russian Academy of Sciences. A member of RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies" (in the last six years 6 promotion papers are reviewed), a member of RTU Faculty of Electronics and Telecommunications Council, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies. Participation in international scientific associations – IEEE. A member and reviewer of the editorial board of the journal Automatic Control and Computer Sciences. Appreciations: Emeritus prof. honoured title, several appreciations for preparation of highly qualified specialists, and honoured Lifetime IEEE membership.

Aleksandrs Ipatovs, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Telecommunications Institute, Head of Telematics and Transport Electronic Systems Group. Scientific research fields: elaboration and research of Telematics and Transport Electronic Systems, Signal Processing and Encoding, Wireless Networks, Computer Network Traffic Analysis, Assessment of Computer Network Performance. Published >26 scientific articles (indexed in SCOPUS). H-index 4. Participation in >10 international conferences with theses (verbal and stand messages). 10 bachelor papers, 3 master papers and 4 promotion papers are advised. Implemented study courses "Fundamentals of Computer Architecture", "Transport Real-Time System Maintenance", "Management of Intellectual Transport System", "Introduction to Computers and Algorithms", "Computer Technologies in Research", "Network Databases and Data banks". The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Member of the RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies" (1 promotion paper reviewed), member of the RTU Constitution Board, member of the Council of RTU FET, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies". Participation in international scientific associations – IEEE and SPIE. A reviewer of international high influence scientific journal articles and a member of the technical programme committee (TCP) of the international scientific conferences - RTUWO, MTTW.

Elans Grabs, Dr.sc.ing, docent, senior researcher, RTU, FET, Telecommunications Institute, Telematics and Transport Electronic Systems Group. Scientific research fields: digital signal processing, traffic of computer networks, machine learning, digital telecommunications. 17 scientific publications (Scopus database), H-index: 3. Participated in several European Regional Development Fund (ERDF) projects and Latvian State Research Programme project implementation. During post-doctoral research promoted international research experience at Johannes Kepler University in Austria. Supervising multiple bachelor's and master's thesis works.

Ģirts Ivanovs, Dr.sc.ing., professor, senior researcher, RTU, Faculty of Electronics and Telecommunications (FET), Telecommunications Institute, Transmission Systems Group. More than 40 years of experience in the field of higher education: administration of the study process, scientific research, and project management. LZP expert in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies (electrical communications, microwaves, optics, fibre optics, WDM, filters, optical filers, PON, optical amplifiers). For more than 10 years, he has been the director of the Institute of Telecommunications and the director of the academic bachelor's, master and doctoral study programme "Telecommunications". Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, member of Institute of Telecommunications Council, and Member of the Board of the Latvian Telecommunication Association for more than 10 years. Co-author for 85 scientific publications available in the Scopus database, and his H-index is 11, co-author for 11 patents. The professor implements study courses: "Communication Transmission Lines", "Fiber Optic Transmission Systems", "Electrodynamics of Driving Systems", and "Optical Transmission Lines", as well as participates in the elaboration of the bachelor papers as a scientific advisor. More than 35 bachelor papers, 40 master papers, and 4 promotion works are advised and successfully defended. Researcher or project manager in more than 10 projects in total.

Jurģis Poriņš, Dr.sc.ing., professor, senior researcher, RTU, FET, Telecommunications Institute, Transmission Systems Group: Head of Group. Professional experience: academic and scientific work experience of more than 27 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics; non-linear fibre optics; non-linear optical effects in fibre optics transmission systems; optical wavelength division multiplexing systems and elements; optical amplifiers; safety parameters in communication lines; sensors and sensor networks), natural sciences - Physics and Astronomy (non-linear fibre optics, study and application of non-linear fibre optics effects, polarization effects and assessment thereof, laser equipment, optical amplifiers, optical frequency combs and application thereof). Expert of the Latvian Council of Science (LZP) since 2012 and corresponding member of the Latvian Council of Science (LZP) since 2018. Director of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, Director of FET Council. From 2015 until 28.02.2022 was the dean of FET and administered the Faculty. Member of RTU Council since 01.03.2022. In total, there are 87 publications published in internationally cited editions and reviewed scientific editions and conference proceedings (from the 52 in Scopus database, H-index is 8), as well as 8 scientific monographs, which are available in EBSCO, ISI WEB of Science, INSPEC, VINITI, VERITAS, Intech and other databases. There are 7 articles published in popular science journals. Participated with theses in 82 international and Latvian scientific and technical conferences. Also participated in panel discussions 5G Techritory forum 2020, UL Student scientific conferences in the discussion about the influence of COVID-19 on science and in other events, as well as took the floor radio broadcasts LR1

“Known in the unknown” (in Latvian: "Zināmais nezināmajā"), and also on television broadcasts TV3 and LTV7. 56 bachelor papers, 62 master papers and 2 promotion works are advised and defended. Implements 8 study courses and qualification upgrading courses for representatives of the field of telecommunications. Co-author for 12 patents. Researcher or project manager in 7 projects in total.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The implementation of the study programme involves both academic staff and highly qualified professionals of the field to fulfil the study courses included in the study programme with the highest quality possible.

The study programme implementation involves 4 professors, 2 associate professors, 4 docents and 1 senior researcher. Professors and associate professors are Doctors of Science with scientific and pedagogical qualification complying with the criteria defined by regulations on professor’s position candidate scientific and pedagogical qualification evaluation.

The analysis of the changes revealed several reasons of such changes:

1. Associate professors and docents have improved their qualification during the review period and were promoted to professors or associate professors;
2. Some of the teaching staff has participated in grant competitions and received funding to conduct research in the field, thus changing their academic position to senior researcher position;
3. New professionals of the field have been hired promoting introduction of new technologies to study courses, therefore new lecturers and assistants were invited to implementation of the study programme;
4. Part of the academic staff have retired.

The weighted average age of academic staff in almost all groups have decreased. These changes are reflected in the table below.

Table 3: Changes of the teaching staff involved in the programme courses

2011/2012			**2020/2021**		
	Number	Average age		Number	Average age
Professor	4	68,5	Professor	4	62,2
Assoc. Professor	1	65	Assoc. Professor	2	42,8
Docent	5	55	Docent	4	45,6
Lecturer	-	-	Lecturer	-	-
Researcher	2	30,5	Researcher	1	35
Total	12		Total	11	

In the implementation of the programme new qualified teaching staff are involved, thus moving the content of the programme closer and closer to the specifics and the relevant topics of the field.

The policy of recruitment, renewal and professional development of the academic staff is based on the regular involvement of master's study programme students, master's degree graduates and doctoral students in the process of studies. Currently, there are 7 lecturers studying at doctoral study programme, which promotes introduction of new teaching techniques and link between study process and their scientific research.

Currently, RTU implements the European Social Fund financed project SAM 8.2.2. "Strengthening of Riga Technical University academic staff in strategic specialisation fields", where one of the tasks is the renewal of the academic staff. The objective of the project is to strengthen RTU academic staff in strategic specialisation fields in 10 study directions. The project activities are in three directions:

- involvement of doctoral students in RTU academic work;
- attraction of foreign academic staff to RTU;
- improvement of competencies of the existing academic staff, including traineeships of the academic staff in companies.

During the project, it is also possible for the academic staff to take professional English language courses and specialised courses.

The academic staff is stable and regularly takes part in various events related to the improvement of qualifications. Improvement of qualification is done by the academic staff through participation in academic and scientific conferences and seminars, and acquisition of various courses. The findings obtained during the improvement of qualification and during the scientific work are embedded into the learning process.

The teaching staff of the programme take part in local and international conferences, which is reflected in the curricula vitae of the teaching staff.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The cooperation of the teaching staff members begins with the planning of the academic year and coordination of the study course project tasks during regular methodological seminars and continues over duration entire semester duration by teaching study courses and planning all the necessary improvements for the next semester at the level of entire study programme.

Each year the study courses of the programme are regularly improved, based on both - recommendations from students and tendencies of the field. During the study courses, regular meetings and methodological seminars of the teaching staff are held, where experience exchange about study course topics take place, and also the content of study courses is elaborated and improved through mutual agreement on topics, directions, responsibilities and correspondence to the normative requirements. In the process, of course, reconciliation all members of the teaching staff are involved, who are taking part in the implementation of a certain study course, providing that the topics included in the study programme are continuously being improved and renewed in cooperation with the professionals involved in the field.

In planning and inclusion of new study courses into the study programme it is mutually reconciled that study courses do not overlap and provide students with the necessary knowledge in each field. When reviewing and actualising a study programme, the teaching staff agree on the most applicable and efficient solutions with respect to the assessment of student achievements and the acquisition of results. When planning a study year and making an agreement on project tasks of the study courses, the disadvantages found before are taken into account and corrections are performed.

When analysing the ratio of students to teachers in the study programme, at the time of submission of self-assessment there are one student for one elected member of the teaching staff.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_EGT0(47523)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_EGT0(47523)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EGT0(47523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EGT0(47523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_EGT0(47523)_CompliancewiththeStateEducationStandard_ProfMag_ENG.pdf	P06_3.2.1_EGT0(47523)_AtbilstibaValstsStandartam_ProfMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_EGT0(47523)_ComplProfStand_ENG.pdf	P07_3.2.1_EGT0(47523)_AtbProfStand_LV.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EGT0(47523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EGT0(47523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EGT0(47523)_Plans_lv_Plan_eng.zip.zip	P09_3.2.1_EGT0(47523)_Plans_lv_Plan_eng.zip.zip
Descriptions of the study courses/ modules	A10_EGT0(47523)_StudyCoursesdescr_ENG.zip	P10_EGT0(47523)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_EGT0(47523)_InternshipManagem_ENG.pdf	P31_EGT0(47523)_PraksesOrganiz_LV.pdf
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Information Technology (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Information Technology*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Jānis*
Surname of the study programme director	*Grabis*
E-mail of the study programme director	*grabis@rtu.lv*
Title of the study programme director	*Dr. sc.ing.*
Phone of the study programme director	*67089594*
Goal of the study programme	*The aim of the Master Academic Information Technology Study Programme is to educate professionals with the highest education in information technology who are able to apply and to optimize advanced information technologies to meet the needs of users within a societal and organizational context and are able to perform scientific research in information technology.*
Tasks of the study programme	*• To provide the comprehensive engineering education and indepth knowledge in information technology; • To prepare students for successful professional career and to train professionals requested by the industry; • To engage students in scientific research and to promote knowledge transfer to the industry; • To develop individual talents of students and to provide stimulating studying experience and environment; • To nurture recognition of the need for and an ability to engage in continuing professional development; • To promote critical and systems thinking and to develop collaboration and cooperation skills; • To explain and to promote information technology in the society.*

Results of the study programme	*• An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution; • An ability to develop integrated information technology solutions for business process automation; • An ability to develop and to apply quantitative modeling methods and methodologies in problem solving context; • An ability to develop data driven decision support information systems; • An ability to develop and to embody enterprise IT management regulations on the basis of industry best practices and standards; • An ability to deliver secure information technology solutions; • An ability to manage the complete life-cycle of information technology solutions; • An ability to plan and to execute information technology with regards to both technical and social aspects • An ability to perform scientific research in information technology.*
Final examination upon the completion of the study programme	*Writing and defense of the Master thesis including a test of knowledge in fundamental areas of information technology.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree in Computer Control and Computer Science, Computer Systems, Information Technology, Intellectual Robotics Systems, Electrical Technologies or Bachelor Degree in Computer Science, Mathematics or Physics or comparable education.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Information Technology*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The classification code of the study program has been changed. During the previous accreditation period, the study program code was 45481, which represented the group of educational programs in Computer Science in the thematic group Natural Sciences, Mathematics and Information Technologies. The change of the code was made pursuant to Cabinet Regulation No 322 of 13 June, 2017.

The most relevant code for the study program is 45526 – educational program group “Other engineering sciences” in the thematic field “Engineering Science and Technology”. Engineering sciences and technologies is the strategic field of specialization of Riga Technical University and the organizational unit in charge of the study program implementation operates in the scientific field of Electrical Engineering, Electronics, Information and Communication Technology. The main aim of the study program “Information technology” is to ensure the development of information technology solutions for the practical use in the industry. These solutions are in essence engineering solutions, the development of which is acquired within the courses of the study program.

The study load has been changed from 81 CP to 80 CP to comply with regulations that one year of studies is 40 CP.

During the reporting period, the requirements towards prior education for admission to the study program changed: a Bachelor’s degree in Computer Control and Computer Science or compatible education. The conditions were supplemented with “or compatible education”. The study program is included in the study field 17 “Information Technologies, Computer Technology, Electronics, Telecommunications, Computer Control and Computer Science”, which unites relevant study programs. Within the scope of these programs, both a Bachelor of Engineering degree and a Bachelor of Natural Science degree in computer systems and information technology are awarded. Both types of the study programs offer fundamental field related subjects. The programs in the field are considered compatible, if their volume and curriculum correspond to the group of compulsory study courses within RTU academic Bachelor study program “Information technology”:

- Study courses in mathematics;
- Field-specific theoretical foundational courses;
- Study courses dedicated to the background of the field or subsfield development and related problems;
- Study courses characterizing a scientific field or subfield and problems on an interdisciplinary basis.

Acquisition of the mentioned study courses is a sufficient condition for successful acquisition of study courses at the Master study programs.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program is implemented in the field “Information Technologies, Computer Technology, Electronics, Telecommunications, Computer Control and Computer Science”, because according to recommendations of ACM/IEEE “A Report in the Computing Curricula Series”, it is one of the basic programs in Computer Science and Information Technology.

The title of the study program precisely characterizes the study field, the goal and the outcomes of the study program. Graduates of the study program work as IT consultants, application developers, IT managers, and systems and modelling specialists. The code of the study program is 45526 in the group of study programs “Other Engineering Sciences” of the field Engineering Science and Technology. Information technology refers to the field of Engineering Science and Technology[1], it was designed according to the strategic specialization of Riga Technical University in Engineering Science and Technology and its curriculum is focused on the development of IT solutions for on-the-job applications in companies and organizations. A degree awarded according to the field of studies is a Master of Engineering in Information Technology. The awarded degree is related to the specialization of the study program Electrical Engineering, Electronics, Information and Communication Technology in the scientific field of Information Technology. For comprehensive acquisition of the education in engineering and information technology, learning outcomes unite acquisition of the principles and theoretical basis of engineering, theoretical basis of computer science, specific aspects of information technology, as well as development and advancement of research skills in the field of information technology.

The study results are complementary and cover all study program specific knowledge areas, which are essential in digitalization of enterprises. That includes IT management, system analysis and modeling and data analysis. Achieving the study results enable to develop, deploy and manage complex and integrated IT solutions in enterprises (study results: An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution; and An ability to develop integrated information technology solutions for business process automation). Horizontal study results (An ability to plan and to execute information technology with regards to both technical and social aspects; and An ability to perform scientific research in information technology) integrate specific knowledge areas and ensures implementation of socially responsible IT solutions in practice as well as to perform scientific research and to develop new technologies.

The volume of the study program of 80 CP (reduced from 81 CP) and the duration of two years meets the Cabinet Regulations No 240 of May 13, 2014 “Regulations on the State Academic Education Standard”. Such a program duration and volume allow strengthening the acquired core knowledge and skills and dedicate sufficiently much time to research work in the course of development of a Master Thesis.

Students with a Bachelor’s degree are enrolled in the program on a competition basis. The competition is organized based on the “Regulations on Enrolment in Post-Graduate Academic and Professional Study Programs” approved by RTU Senate. The competition takes into account the weighted average grade received during the undergraduate studies. The study program strengthens and broadens knowledge acquired in undergraduate studies. Therefore prospective students are required to have an undergraduate degree in Computer Control and Computer Science, Computer Systems, Information Technology, Intellectual Robotics Systems, Electrical Technologies or Bachelor Degree in Natural Sciences in Computer Science, Mathematics or Physics or comparable education.

[1] https://likumi.lv/ta/id/296661-noteikumi-par-latvijas-zinatnes-nozarem-un-apaksnozarem (only in Latvian).

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Information technology is one of the most significant and fastest growing sectors of the Latvian economy, which constantly needs young specialists. IT specialists are characterized with high social mobility, and the sector provides essential input for regional development.

Graduates of the study program work for IT companies in Latvia and globally, as well as for the companies that apply complex IT solutions. The major employers are “Accenture”, “Tieto”, “Latvenergo”, “TET”, “ZZ Dats”, “Luminor”, “Visma”, " Wonderland Media”, “Squalio Cloud Consulting”, “Ernst & Young”, “Latvijas Mobilais Telefons”, “C.T.Co”, “Scandiweb”, etc.

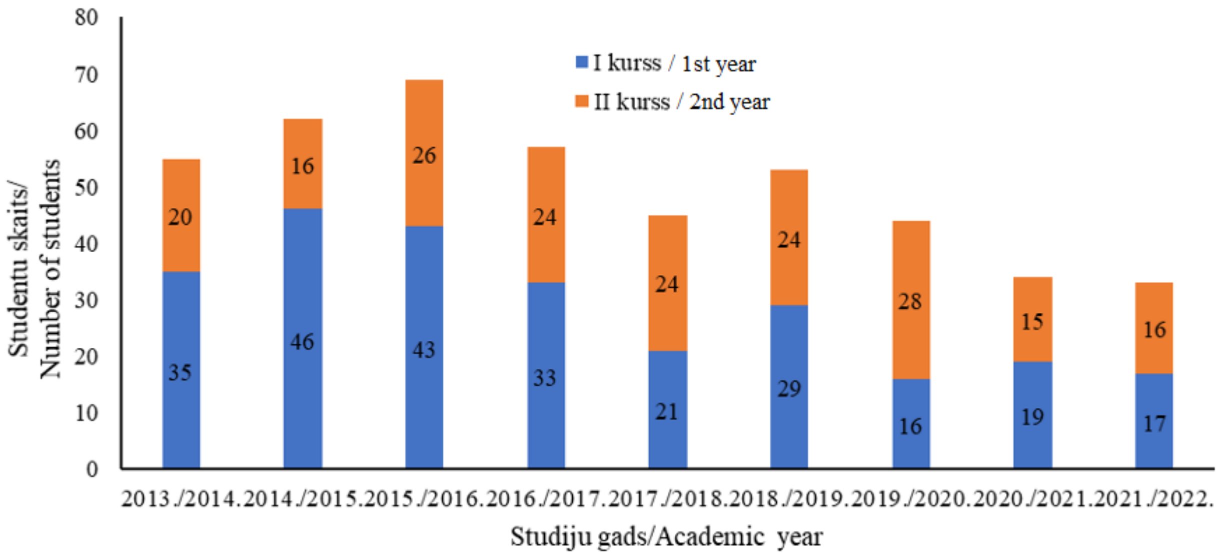
Graduates work as IT consultants, developers of application software, programmers, systems analysts, system administrators, testers and other IT professionals. ICT sector is a high added value sector. Its professionals earn 60% greater salary than the average salary in the country, and it is the second in the list of best paying sectors (https://stat.gov.lv/lv/statistikas-temas/darbs/alga/preses-relizes/6568-darba-samaksa-2020-gada (only in Latvian)). The sector makes a substantial contribution to the Latvian economy, producing 5% of the total national value added. (https://lddk.lv/wp-content/uploads/2020/06/zinojums_ts_062018.pdf (only in Latvian).

Unemployment ratio among program graduates is very low. Only 1.4% of the total number of graduates are unemployed, but 7.4% are economically inactive for various reasons (statistical data for 2017-2018 on employment ratio among graduates of the Latvian higher education establishments). The STEM sector is expected to experience shortage of workforce in 2027 – 14,000 specialists, which means that graduates of the study program are vitally important for the national development and in the longer term they have good employment opportunities (https://likumi.lv/ta/id/324332-par-izglitibas-attistibas-pamatnostadnem-2021-2027-gadam (only in Latvian)).

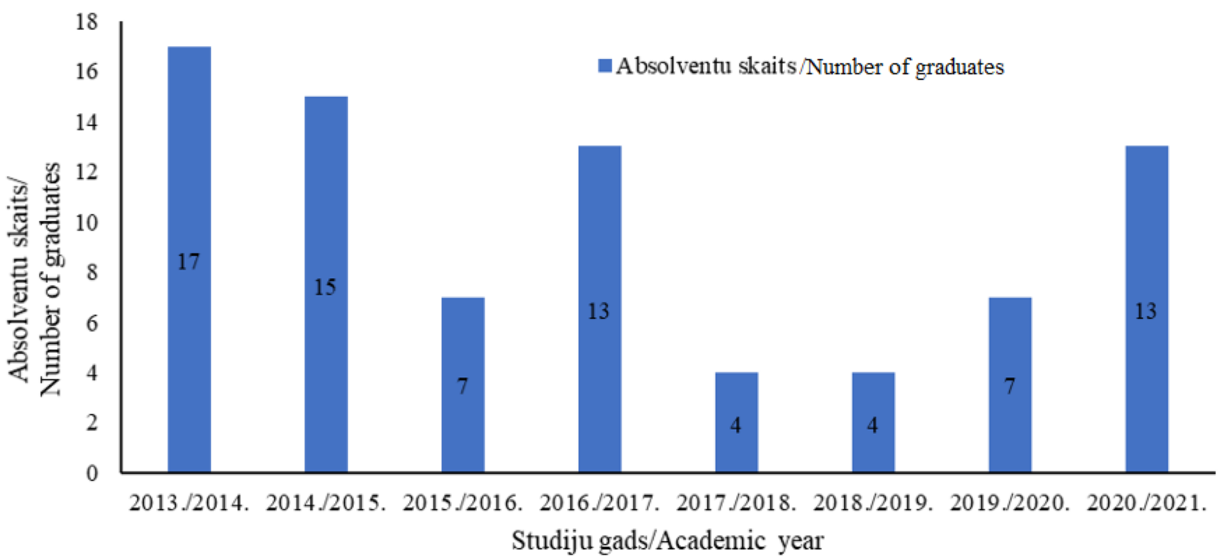
In the field of information technology, highly qualified specialists play an essential role since they have to deal with the systems of high complexity. IT specialists with a Master’s degree earn 20-25% more than specialists with completed secondary education (https://www.cv.lv/). Leading specialists also have higher employment rates.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

During the reporting period, there were 50 students in the study program on average, and every year 29 students are enrolled on average. The study program has received the decision from the Council of Higher Education on eligibility of its implementation. The number of students tends to decrease. Such a trend corresponds to the general trend in the European Union, which will result in reduction of the number of Master students. It is a subject to an essential influence of demand for IT specialists in the sector, and students face difficulties in combining studies with work. This also is the reason for 25% of drop-outs in the first academic term. To resolve the problem, the study program places a greater emphasis on involvement of students in research projects, not only on the student number increase.



During the reporting period, significant fluctuations in the number of graduates is observed, which changed from 4 to 17 graduates. Still, the study program managed to reduce the critical decrease that was observed in academic years 2017/2018 and 2018/2019. RTU has introduced the changes that allow developing a Master Thesis in the form of scientific publications. Such practice is also planned to be applied to the study program Information Technology, which would allow students to focus on achievement of research results and their effective dissemination.



3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The objective of the study program is to educate and train students for employment in the IT sector, as well as for individual research work in the field of IT, putting the main emphasis on system modelling, big data and decision-making technologies, company digitalization and IT governance. The curriculum of the study program is aimed at training IT department managers and responsible personnel, having mutually complementary knowledge about a company’s IT activities and company digitalization. Study courses in IT governance offer knowledge in establishment and operation of a company’s IT core structure, study courses in system design and digitalization offer knowledge in technological maintenance of a company’s business processes, and study courses in data processing and system modelling offer knowledge in data-based system analysis and improvement of business operations.

The study program consists of the compulsory study courses (37 CP), compulsory elective study courses (19 CP), elective study courses (4 CP) and Master Thesis (20 CP). IT governance is considered by DMI744 Information Technology Governance, DOP715 Reliability of Information Systems, and DOP701 Portfolio Management Technologies; digitization issues are considered by the study courses DOP723 Digital Transformation, DMI548 Design of Management Information System and DMI470 Logistics Information Systems. System modelling issues are considered in detail by study courses DMI543 Systems Simulation and Modelling Technology and DPI551 Object-Oriented System Analysis. Data processing and big data technologies are considered by the study courses DID501 Modern Technologies of Decision Analysis, DSP424 Large Databases and DMI728 Data Mining and Knowledge Discovery. The compulsory part of the study program comprises the study courses dedicated to recognition-theoretical research and approbation for information technology sector, as well as to scientific research methods in the volume of 24 CP. Research methods are emphasized in the study courses DMI728 Data Mining and Knowledge Discovery, DMI543 Systems Simulation and Modelling Technology, DMI744 Information Technology Governance and DOP723 Digital Transformation, with the curricula being acquired based on the research work. Respectively, they provide for the acquisition of data analysis, of experimental, summarizing and case study methods. DMI470 Logistics Information Systems, DOP701 Portfolio Management Technologies and

DPI551 Object-Oriented System Analysis place a greater emphasis on the latest scientific achievements in the industry, also presenting research results achieved by the members of the academic staff Prof. E. Ginters, Prof. J. Grabis and Prof. O. Ņikiforova.

Table below summarizes contribution of each course to achieving the overall study results of the study program. The core of study courses concerns formal analysis of IT problems and implementation of IT solutions at enterprises (the first two study results). The third to sixth study results concern specific digitalization aspects, which are covered in at least one mandatory course and several electives. Humanities and social science courses contribute to development of understanding of IT in the societal context. Scientific research abilities are developed gradually in several study courses and culminate in writing Master Thesis.

Study results								
1	2	3	4	5	6	7	8	9
DID412 DID501 DID536 DMI470 DMI500 DMI543 DMI548 DMI727 DMI744 DMI747 DMI748 DOP407 DOP707 DOP715 DOP723 DPI551	DMI458 DMI470 DMI500 DMI543 DMI548 DMI554 DMI727 DMI747 DMI748 DOP707 DOP723 DPI551 DSP424 IUV456 (	DMI543 DMI728 DMI747	DID412 DID501 DID533 DID536 DID538 DMI728 DOP707 DOP715 DSP424	DMI744 DOP407 DOP705 DOP715	DMI748 DOP707 DOP715 (	DMI470 DMI500 DMI548 DMI744 DMI748 DOP407 DOP701 DOP723 DPI551	DMI470 DMI500 DMI548 DMI744 DMI747 DOP701 DOP723 HFL433 HSP446 HSP484 HSP488 IRU116 IUE217 IUV305	DID412 DID501 DMI002 DMI543 DMI727 DMI728 DMI744 DOP002 DOP723 HFL433

Digital transformation, big data technologies and application of artificial intelligence, cloud computing, cybersecurity and merging of digital and virtual spaces (i.e., digital twins and augmented reality) are topical trends in information technology. Compliance of the study courses to the labor market and knowledge development trends is provided through updated study courses, selection of themes for the term papers and changes to the study program. During the reporting period, the study program had undergone significant changes, having launched new study courses DMI728 Data Mining and Knowledge Discovery, DOP71 Information System Security Governance, DOP723 Digital Transformation and DOP701 Portfolio Management Technologies that reflect recent developments in the field of machine learning, cybersecurity, digitalization and system development. For example, the study course DOP701 Portfolio Management Technology replaced the study course Project Management, because a greater emphasis is placed on co-design of a variety of projects and programs in the sector.

Updating of the curriculum of the study courses is carried out according to RTU regulations. If essential changes have been made to the content, they are considered by the Committee in the field of “Information Technologies, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science”, which also involves representatives of the industry. Operational changes are made when elaborating a calendar plan for the next academic term according to RTU regulations concerning the use of the e-learning environment in the delivery of the study courses. Methodological Committee of FCSIT considers the relevant issues. At the faculty seminar for the academic staff, issues of study process digitalization, application of modern teaching methods, evaluation of learning outcomes and academic integrity are discussed.

Presentation of scientific achievements is based on the academic staff activities in international and national research projects, and project results are integrated in the study courses (the full list of research projects of the academic staff is available in the CVs). Research results are integrated in the curriculum of the study courses.

Academic staff	Study course	Most significant research projects
Jānis Grabis	DOP723	European Commission FP7 project, “CaaS: Capability as a Service in Digital Enterprises”, 2013-2016 State research program, “ARTSS: Prospective technologies for sustainable and safe services”, 2020-2021
Jurijs Merkurjevs	DMI543	ERA-NET (ERA/Net-LAC) funded project FuturICT 2.0 “Wide scale experiments and simulations for the second generation of FuturICT”, 01.02.2017. - 9.08.2021 within the 7th framework program. Estonia-Latvian-Russian cross-border cooperation program project No. ESTLATRUS/2.1./ELRI-184/2011/14 “Integrated Intelligent Platform for Monitoring the Cross-Border Natural-Technological Systems” ELRI-184, INFROM, 15.02.2012. - 14.02.2014.
Egils Ginters	DMI470	ERA-NET (ERA/Net-LAC) funded project FuturICT 2.0 “Wide scale experiments and simulations for the second generation of FuturICT”, 01.02.2017. - 9.08.2021 within the 7th framework program. Project of the Latvian Council of Science “Evaluation of Latent Factors’ Influence on Digital Technology Sustainability Development”, 19.11.2020. - 21.12.2021.
Andrejs Romanovs	DMI744	ERASMUS+ project on development of cybersecurity curriculum on smart grids
Arnis Leaktauers		Planning of multimodal movement and development of an effective evaluation tool prototype. Voucher project LV8966, Contract on experimental development No. JS 8/2021i in cooperation with “Karšu izdevniecība Jāņa sēta”.
Sergejs Paršutins	DMI728	Industry project on identification of unusual behavior using mashine learning
Oksana Ņikiforova	DPI551	Industry project on analysis user behaviour in CAD systems to generate usage recommendations

Trends in the industry help involve large IT companies in academic partner programs, which allows using the latest software and guidance materials. The study program in IT technology uses materials from “Microsoft Academic Alliance”, “SAP University Alliance”, “Jira” and “Tableau”. For example, “Microsoft PoweApps” platform is used within DOP723 Digital Transformation and “Jira” and its plug-in generated opportunities are employed within DOP701 Portfolio Management Technologies.

On the annual basis, a guest lecture “Accenture Baltic” on the latest trends in technology development run by “Accenture Technology Vision” is delivered within the scope of the study program.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

One of the objectives of the study program is development of scientific research skills. It can be achieved through integration of latest scientific developments in the study program, doing research in the framework of the study courses, involvement of students in research projects and doing research developing the Master Thesis. Scientific research is mainly carried out in systems analysis, modelling and design, the sub-sector of electrical engineering, electronics, information and communication technology, as well as in the theory of intelligent systems in the field of computer science and informatics.

The major areas of research that students are involved in:

1. Digitalization;
2. IT governance and cybersecurity;
3. Big data technologies and intelligent systems;
4. Modelling and analysis of complex systems.

The study courses integrate the new knowledge in these fields. DOP715 Reliability of Information Systems allows students to analyze and identify security risks in machine learning applications, DMI470 addresses augmented reality and sustainable IT development issues, DOP723 also considers low-code approaches (“low-code”) and the study course DMI727 High Performance Computing Technology CUDA investigates solution of highly complex tasks with the help of high-performance computing. The following international and national research projects are being implemented in these fields:

1. FP7 ICT Program Collaborative Project “CaaS – Capability as a Service for Digital Enterprises”, 01.09.2013.-01.09.2016.
2. Project of the European program COST action European Cooperation in Science and Technology TD1406 “Innovation in Intelligent Management of Heritage Buildings”, 6.05.2015. -.5.05.2019.
3. FP7 ERA-NET (ERA/Net-LAC) project FuturICT 2.0 “Wide scale experiments and simulations for the second generation of FuturICT”, 01.02.2017. - 9.08.2021.
4. Estonia-Latvian-Russian cross-border cooperation program project No ESTLATRUS/2.1./ELRI-184/2011/14 “Integrated Intelligent Platform for Monitoring the Cross-Border Natural-Technological Systems” ELRI-184, INFROM., 15.02.2012. - 14.02.2014.
5. Grant project of the Baltic Research Program of the EEA/N Financial Instrument 2014-2021 “Raising society's cybersecurity capabilities (ADVANCES)”, 01.01.2021 - 31.12.2023.

6. Project of the State Research Program “Mitigation of Covid-19 Consequences” “ARTSS: Perspective Technologies for Sustainable and Safe Services”, 01.07.2020 - 31.12.2020.
7. LCS project “Assessment of the Sustainability Development of the Latent Impact Digital Technologies” 19.11.2020. - 21.12.2021.

In the international evaluation of scientific institutions carried out in 2019, FCSIT was ascribed the rating “4” according to the 5-grade scale. The evaluation placed a special emphasis on the contribution to economic development. The high grade shows high scientific potential of the academic staff at FCSIT and the study program, which also greatly contributes to the Master studies. In the course of studies, students develop scientific publications, which are also indexed in the international bibliographic databases:

1. Aboltins, U., Novickis, J. & Romanovs, A. 2020, "IoT Impact on Business Opportunities", 2020 61st International Scientific Conference on Information Technology and Management Science of Riga Technical University, ITMS 2020 - Proceedings.
2. Bormane, L. & Bērziša, S. 2017, Role of “bridge person” in software development projects.
3. Cīrule, D. & Bērziša, S. 2019, Use of chatbots in project management.
4. Deksne, L., Grabis, J. & Žeiris, E. 2021, Towards Data Ecosystem Based Winter Road Maintenance ERP System.
5. Grabis, J., Bondars, Z., Kampars, J., Dobelis, E. & Zaharcukovs, A. 2017, "Context-aware customizable routing solution for fleet management", ICEIS 2017 - Proceedings of the 19th International Conference on Enterprise Information Systems, pp. 638.
6. Grabis, J. & Ivanecka, A. 2014, "Continuous improvement of enterprise applications", BIR 2009 - 8th International Conference on Perspectives in Business Informatics Research.
7. Grabis, J., Kampars, J., Bondars, Ž. & Dobelis, Ē. 2017, Design of vehicle routing capability.
8. Grabis, J., Minkēviča, V., Haidabrus, B. & Popovs, R. 2020, Is Team Always Right: Producing Risk Aware Effort Estimates in Agile Development.
9. Kampars, J., Grabis, J., Matisons, R. & Vindbergs, A. 2021, "On integration of evolving infrastructure topology graphs and metric data streams in information technology infrastructure management", Vide. Tehnologija. Resursi - Environment, Technology, Resources, pp. 62.
10. Kempelis, A., Romanovs, A. & Patlins, A. 2021, "Design and implementation of IoT network prototype to facilitate the food production process in agriculture", EUROCON 2021 - 19th IEEE International Conference on Smart Technologies, Proceedings, pp. 71.
11. Kempelis, A., Romanovs, A. & Patlins, A. 2021, "Implementation of Machine Learning based Approach in IoT Network Prototype", Proceedings of the 9th IEEE Workshop on Advances in Information, Electronic and Electrical Engineering, AIEEE 2021.
12. Platonova, V. & Berzisa, S. 2019, "Gamification framework for software development project processes", Vide. Tehnologija. Resursi - Environment, Technology, Resources, pp. 114.
13. Podjavo, I. & Berzisa, S. 2017, "Performance evaluation of software development project team", Vide. Tehnologija. Resursi - Environment, Technology, Resources, pp. 118.
14. Podzins, O. & Romanovs, A. 2017, "Designing a evaluation tool for IT security solution implementation for IT enterprises", 2016 IEEE 4th Workshop on Advances in Information, Electronic and Electrical Engineering, AIEEE 2016 - Proceedings.
15. Rasnacis, A. & Berzisa, S. 2016, "Method for Adaptation and Implementation of Agile Project Management Methodology", Procedia Computer Science, pp. 43.
16. Romanovs, A., Sultanovs, E., Buss, E., Merkuryev, Y. & Majore, G. 2021, "Challenges and Solutions for Resilient Telemedicine Services", 2020 IEEE 8th Workshop on Advances in Information, Electronic and Electrical Engineering, AIEEE 2020 - Proceedings.
17. Roponena, E., Kampars, J., Gailitis, A. & Strods, J. 2021, "A Literature Review of Machine Learning Techniques for Cybersecurity in Data Centers", ITMS 2021 - 2021 62nd International

Scientific Conference on Information Technology and Management Science of Riga Technical University, Proceedings.

18. Rusakovs, V. & Grabis, J. 2014, Object-oriented development of adaptive workflows for customer flow management processes.
19. Skrebeca, J., Kalniete, P., Goldbergs, J., Pitkevica, L., Tihomirova, D. & Romanovs, A. 2021, "Modern Development Trends of Chatbots Using Artificial Intelligence (AI)", ITMS 2021 - 2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University, Proceedings.
20. Skrodelis, H.K. & Romanovs, A. 2021, "Cyber-physical Risk Security Framework Development in Digital Supply Chains", ITMS 2021 - 2021 62nd International Scientific Conference on Information Technology and Management Science of Riga Technical University, Proceedings.
21. Skrodelis, H.K., Strebko, J. & Romanovs, A. 2020, "The Information System Security Governance Tasks in Small and Medium Enterprises", 2020 61st International Scientific Conference on Information Technology and Management Science of Riga Technical University, ITMS 2020 - Proceedings.
22. Sultanovs, E. & Romanovs, A. 2017, "Centralized healthcare cyber-physical system's data analysis module development", 2016 IEEE 4th Workshop on Advances in Information, Electronic and Electrical Engineering, AIEEE 2016 - Proceedings.
23. Sultanovs, E., Skorobogatjko, A. & Romanovs, A. 2016, "Centralized healthcare cyber-physical system's architecture development", 2016 57th International Scientific Conference on Power and Electrical Engineering of Riga Technical University, RTUCON 2016.
24. Sultanovs, E., Strebko, J., Romanovs, A. & Lektauers, A. 2020, "The Information Technologies in the Control Mechanism of Medical Processes", 2020 61st International Scientific Conference on Information Technology and Management Science of Riga Technical University, ITMS 2020 - Proceedings.
25. Suponenkovs, A., Sisojevs, A., Mosans, G., Kampars, J., Pinka, K., Grabis, J., Locmelis, A. & Taranovs, R. 2017, "Application of image recognition and machine learning technologies for payment data processing review and challenges", Proceedings of the 5th IEEE Workshop on Advances in Information, Electronic and Electrical Engineering, AIEEE 2017, pp. 1.

In order to build an active research environment, the Institute of Information Technology publishes the article collection "Information Technology and Management Science", organizes the annual international scientific conference "IEEE Information Technology and Management Science Conference" (http://itms.rtu.lv/), runs separate section of the institute's workshops and student conferences. Master students are actively engaged in all these activities.

The significance of Master studies is also attested by involvement of the study program's students and academic staff in contracts with the industry and projects of the Competence Center:

1. ERDF project "The Competence Centre in Information and Communication Technologies", research "Multicriteria route planning for business transport", 2016-2017.
2. ERDF project "The Competence Centre in Information and Communication Technologies", research "Establishment of software adaptation algorithms and modules according to contextual information of user activity audit log", 2016-2018.
3. ERDF project "The Competence Centre in Information and Communication Technologies", research "Adaptive cloud computing platform scaling method according to a configured parameter set", 2016-2017.
4. ESF project, procurement for Vidzeme planning region "Optimization possibilities of public transport route network in Vidzeme by taking into consideration the needs of population and public transport service providers" 11.2011.-12.2020.
5. ITKC project with "ZZ Dats" Ltd., "Development of Framework for Designing an Analytical

Data Warehouse for E-government", 2019-2020.
6. ITKC project with "DATI Group" Ltd., "Resource-saving computing task optimization solutions", 2019-2020.
7. Practice-oriented research program project with "ZZ Dats" Ltd., "IWiRoM: Development of a new type of Intelligent Winter Road Maintenance information system and ERP integration solution for improving efficiency of maintenance processes", 2021-2022;
8. Practice-oriented research program project with JSC "TET", "Development of a solution for dynamic IT infrastructure adapted, integrated monitoring and predictive maintenance (DIPIM)", 2021.
9. Development of multimodal moving planning and effective evaluation tool prototype. Voucher project LV8966, contract on experimental development No. JS 8/2021i with "Karšu izdevniecība Jāņa sēta".
10. Contracted research on intelligent electrical power governance systems for multi-apartment buildings and development of the integrable equipment for effective use of network connections and availability of new services, 2021-2023.
11. Contracted research on development of big data driven ICT security governance solution (BICTSeMS), 2021-2023.
12. Contracted research on horizontally scalable open IoT cloud computing platforms and the integrable machine learning model design and development.
13. Development of the prototype "Intelligent system for object recognition".
14. Development of automated job input solution.
15. Development of an evaluation simulation model for evaluation of CyptoPolice decision-making algorithm.
16. Development of a new supply and demand management system and the providing equipment for balancing the electrical load the level of transmission networks and connection.
17. Evaluation of a company's digital maturity and detailed description of three scenarios of digital twin development.
18. Planning of work stations based on the theory of organizational networks.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study program is organized using the strategic aims and tasks of RTU as its basis:

- Scientific research excellence implied involvement of the students in research work. Students take part in the student conferences and other research-related events;
- Academic excellence is ensured actively involving industry representatives in educating and training of students to train competitive specialists for the international labor market;
- Organizational excellence is ensured involving representatives of the student government in the governance of the study program. Representatives of different organizational units

cooperate in the process of implementation of the study program. Individual work stations and access to modern software and IT infrastructure is provided for the students.

Basic principles of internal quality assurance at the study program include:

- Responsible instructors are in charge of the study courses, their activities are controlled by the responsible organizational unit;
- Planning and control of the study program are carried out by the head of the study program;
- Methodological activities are run through a series of methodological seminars organized by a responsible organizational unit;
- Learning outcomes are evaluated and changes to the study program are made by the ITI council;
- The head of the study program controls the use of the e-learning environment.

RTU internal quality management system functions according to the Excellence Approach approved by RTU Senate on 30 January, 2017 (minutes No. 606; see: https://www.rtu.lv/writable/public_files/RTU_excellence_approach.pdf), as well as to RTU Quality Policy (minutes No. 612; see: https://www.rtu.lv/writable/public_files/RTU_quality_policy_of_rtu.pdf) approved on 25 September, 2017.

The Quality Policy is aimed at completion of RTU mission and strategic goals – achievement of research, academic, infrastructure, and organizational excellence and recognition. The Quality Policy forms the framework for implementation of RTU Strategy, paving the way for development and improvement of research, studies and organization. The university Quality Policy is in agreement with the standards and guidelines of ENQA (European Association for Quality Assurance in Higher Education). RTU Excellence Approach and Quality Policy are mutually integrated documents, which stipulate that RTU uses EFQM (European Foundation for Quality Management) as a quality model.

The didactic approaches of the study program are based on the studies rooted in research. In the 1st year of studies, students acquire compulsory study courses. In the 2nd year of studies, students strengthen their knowledge in elective study courses in one of the core fields of the study program and choose the topic of the thesis, which is supposed to be written during the spring academic terms of the 2nd year of studies.

The study program is implemented as full-time studies in Latvian, meeting in parallel the requirements of regulatory enactments, basic education organization principles of RTU and fulfilling all requirements of the study courses. Descriptions of the study courses of the program specify the corresponding body of knowledge, skills and competences, and their evaluation system, define learning outcomes to receive credit points. The assessment procedure for students' knowledge, skills and competences is specified in the decision of RTU Senate of 27 May, 2017 "On the Regulation on the Assessment of Learning Outcomes" that is in compliance with the basic principles and procedure of education assessment defined by Cabinet regulations in the relevant education cycle. Summative assessment is used in the assessment of learning outcomes, when the final grade consists of several components. Full-time studies imply acquisition of 40 CP per academic year and the workload of 40 hours of studying per study week, which makes 1 CP. Within the Master studies, 40% of the workload is taken by contact hours and 60% is individual work (self-education).

Delivering the study courses, academic staff select a didactic approach appropriate for a topic, coordinating the distribution of study loads, learning outcome assessment methods and basic organizational issues of the study courses, i.e., individual or group work, at the level of the study program. Normally, contact hours for lectures and classes in the study program are evenly distributed. Classes usually take place in small groups in a computer classroom. Regarding the academic issues, individual approach is ensured according to the methodology approved by RTU Rector order “On the Guidelines for Planning the Work of Academic Staff”, which specifies that the academic staff must provide consultations for each group of 25 students per lecture flow in the volume of 15% of total lecture hours. In addition, individual consultation hours are planned for supervision of study papers and projects, internship reports and graduation papers. Pre-examination consultations are organized before exams. In necessary, students can apply directly to the academic staff members outside consultation hours, by sending relevant questions either as a message, or in a corresponding study course forum in ORTUS system, or by email.

E-learning is also actively used in the study process. Student surveys show that all students have adequate hardware to take part in the e-learning process. Students also specify that online full-time studies are the most appropriate kind of studies for them, which let them improve their learning outcomes. However, full-time studies on campus will remain to be an important element of the study program to effectively solve complex problems in laboratories and to promote cooperation through discussions. For example, laboratory works in the study course DOP715 Reliability of Information Systems are tailored both for online and on-site studies.

Study analytics is used in the study process. The academic staff monitor student activities in the e-learning environment, evaluating the most useful study materials and identifying the necessary motivating activities. Opportunities offered by “MS Teams” are used for student activity assessment and “MS Forms” and Ortus opportunities to conduct real-time online surveys and discussion of the learning outcomes are used in organizing the remote study process.

One of the goals of the study program is development of team work and communication skills. Within post-graduate studies, student also learn how to coordinate the work across teams by imitating activities of a large company. This is implemented within the study course DOP701, where many student teams coordinate their activities when solving an IT problem.

Laboratory works within DOP723 Digital Transformation are carried out as small-scale research, where students apply the knowledge acquired in other study courses, for example, statistical analysis of results. Furthermore, the individual work in the study course is carried out as research, which results in a draft of a scientific publication to be optimized during development of a Master Thesis.

The curricula of the study courses are closely related to research work done by the academic staff. DMI543 Systems Simulation and Modelling Technology is based on the research in simulation modelling conducted by Prof. J. Merkurjevs and Assoc. Prof. J. Pečerska. Research work in the study course DOP723 Digital Transformation is carried out according to the methodology developed by Prof. Jānis Grabis on evaluation of digitalization alternatives *Grabis, J. (2021). Transformation and Enactment of Data-Intensive Business Processes Using Advanced Architectural Styles. In: Zimmermann, A., Schmidt, R., Jain, L. (eds) Architecting the Digital Transformation. Intelligent Systems Reference Library, vol 188. Springer, Cham*. The study course DMI470 Logistics Information Systems is based on the latest research of Prof. E. Ginters *Ginters, E. & Revathy, J.C. 2021, "Hidden and latent factors’ influence on digital technology sustainability development", Mathematics, vol. 9, no. 21.*

At the practical classes within the study course DMI554 Management Component Integration, such active kind of learning as simulation games are widely used, which promote application of theoretical knowledge in solving practical tasks, as well as allow solving complex problems and work in teams.

In the study process, skills to cooperate with students of other study programs and other countries are also acquired. The course DOP701 Portfolio Management Technologies is delivered simultaneously to the students of the study program Business Informatics and foreign students from France, Germany, India and other countries. Using remote learning opportunities, the leading specialists from Austria and Canada delivered guest lectures within the study program, an international group of experts took part in the evaluation of study papers.

If during their undergraduate studies, students did not complete study courses that ensure achievement of professional competencies in entrepreneurship, technology transfer, product development, civil protection or environment protection, and the study courses similar in terms of their curricula are not included in the compulsory part of the acquired Master program, students have to acquire these courses in addition to the Master study program. The list of additional study courses to be acquired and their volume based on the analysis of the previously acquired study program are determined by the head of the study program or an expert authorized by them and approved by an order of the head of the responsible structural unit.

The most important aspects of the student-centered approach are described below.

1. Involvement of students in the study process and updating of the curriculum

According to RTU procedures, students can regularly give feedback about the curriculum. Students at the program are regularly involved in assessment of the study program quality and take part in decision-making bodies and advisory bodies (the Faculty Council, the Methodological Committee, the Study Field Committee). In addition to formal processes, students regularly meet with the Program Director, when the content and quality of studies is discussed. Mid-term and semestral surveys are organized to let students give feedback about the study courses. Furthermore, at any time students can apply to the Program Director or RTU Study Department with an option to complain anonymously, in order to let them know about problems arising during the studies. Graduates of the study program fill in the form about the studies in general.

2. Learning outcomes

At the study courses, the academic staff clearly define the learning outcomes to be acquired, as well as connect the results with the study program outcomes and credit points of the course. The academic staff take into account diversity of students, offering tasks of different complexity, as well as offering learning materials for the acquisition of both the basics of a study course and the in-depth knowledge of the curriculum of a study course. Students also are offered a vast variety of educational materials (documents, presentations, video recordings, interactive educational materials, etc.).

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. RTU also regularly uses the opportunity to invite guest lecturers to share their experience with students in the form of individual guest lectures or complete study courses. By meeting guest lecturers in specially organized seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad. Further information on guest lecturers and academic staff mobility is given in section 3.4.1 “Assessment of the compliance of the qualification of the teaching staff members”.

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs. Students take up employment early. Remote learning opportunities help students combine studies with work.

5. Teaching and learning methods

Within the program, various teaching and learning methods mentioned above are implemented, they are adapted by the academic staff to each particular situation (see the description at the beginning of the section). Students can attend individual consultations, including communication in the e-environment using RTU licenses on Zoom and MS Teams platforms, as well as Moodle instant message services.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Embarkment. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classes. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools).

In the process of program implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.).

7. Development of the academic staff competences

The academic staff involved in the implementation of the program is provided with opportunities to improve their methodological and didactic skills on a regular basis. The process of academic staff competence development includes methodological seminars organized by the Institute of Business Computer Systems and FCSIT on the application of teaching and learning methods, including innovative machine learning methods, as well as RTU methodological conference. In the framework of SAM 8.2.2. project, the opportunity to undergo internship at IT companies is provided, thus letting the academic staff acquire the latest approaches and methods applied in the industry in order to cover them in their study courses. The project mentioned above also gave opportunity to attract new members of the academic staff, especially PhD students, to teaching activities in the study program.

8. Extracurricular student activities

Students at the program are offered a vast variety of extracurricular activities:

- the management of the program and the faculty actively support student self-government activities and encourages students to take part in them, thus letting them increase their autonomy, giving students an opportunity to implement their ideas, as well as the opportunities of supplementary studies outside lectures.
- Every student of the program is offered opportunities to take part in extracurricular activities (sport teams, dance groups, choirs, etc.).
- Students are also engaged in scientific and research work on the relevant issues in the field, taking part in both local and international projects, resulting in their chances to participate in

international conferences.

The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

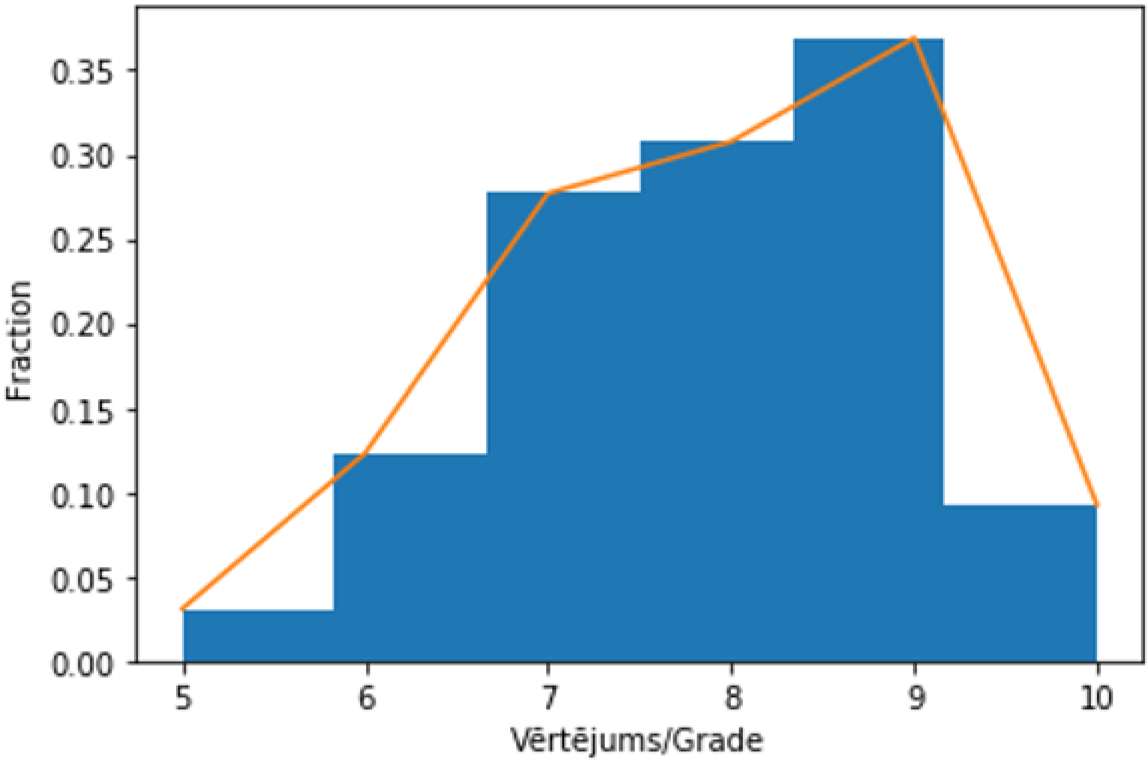
Students develop their Master Theses in the second year of studies. The themes are specified by the relevant research carried out by the department, prospective research fields investigated by the academic staff and topical issues at students' place of employment. Since 2016, altogether 49 Master Theses have been defended. Those theses studied current areas in the field of information technology: cybersecurity (4), augmented reality (2), big data technologies and machine learning (19), cloud computing (4) and complex company systems (8). The most popular application areas include medicine and transport. For example, "Application of machine learning methods in detection and reconstruction of important face points" and "Application of graphical processor based computer vision technologies in automated vehicle driving systems". A variety of papers were written exactly in the framework of research projects: "Use of Intelligent Solution Support Systems in Logistics Route Tasks", "Determination of Data Interrelation in Partly Open Data Ecosystems", "Development of Process Control Information Systems in Healthcare", "Development of Methods for Human Gait Types Recognition in Smart Textile Signals", "Research of Various Sensors and Technologies in Designing an IoT Network to Facilitate the Food Production Process in Agriculture" and others.

The mentioned research has contributed significantly to achievement of results in the State Research Program, "ARTSS: Promising Technologies for Sustainable and Safe Services" (2020-2021), where the suggestions on implementation of safe telemedicine in Latvia were developed.

The research results are applied in practice, especially, the research in IT solutions in transport and medicine, for example, "Simulation-based Public Transport Multi-modal Hub Analysis and Planning", "GIS-based Location Choice Analysis for Trading Company", "Application of Data Mining Methods to Medical Data Analysis" and "The Comparative Analysis of Classifiers for Therapy Outcome Prediction Problem".

The average grade for the theses is 8 (data for the whole reporting period), and the most frequent grade is 9. The comparatively high grade shows that lower graded papers have not been finished or have not been approved for viva voce. Unfortunately, those students, who failed to complete their paper at the first attempt, seldom try to improve their paper. The study program has not experienced any cases when students changed their topic of paper. Average values of student scores remained unchanged during the reporting period.

Figure shows a fraction of Master thesis receiving the specified grade in the reporting period.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- FCSIT Institute of Information Technology;
- FCSIT Institute of Appllied Computer Systems;
- RTU Faculty of E-learning Technologies and Humanities;
- RTU Faculty of Engineering Economics and Management

RTU institutes and their departments ensure the training and methodological work: develop and update the curriculum, provide delivery of corresponding study courses, supervision and examination of PhD theses and carry out other activities related to teaching, methodological and research work. Elective study courses are offered also by other organizational units of RTU and other higher educational establishments. The study program is granted with assistance of the general RTU support staff, which provides the functioning of the infrastructure.

Riga Technical University provides the study program with a corresponding learning environment. It comprises lecture halls and classrooms, laboratory equipment, e-learning environment and bibliographic resources. Each study course is provided with a necessary learning environment.

The studies take place at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at 10 Zundas Embarkment, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The faculty is located in the same building with RTU Scientific Library, providing rooms for group work and quiet reading rooms. The conference center offers a large lecture hall with 500 seats, the faculty has 12 lecture halls with 25-200 seats and computer classes with 20-25 workstations. Students can use their laptops and connect to RTU Wi-Fi networks. The lecture halls are equipped with modern audio and video equipment, including a digital projector, a computer, a remote control, audio devices, microphones and cameras.

Modern software that corresponds to educational needs and the current trends is used in the study process:

- FCSIT cloud computing platform “CloudStack”, created within the ERDF project “(IKSA-CENTRS) Establishment of national research center of information, communication and signal-processing technologies”. Students can also connect to “Microsoft Azure” cloud computing environment;
- agreements on the free use of software in research are signed, e.g., the agreements with MatLab, CPLEX, Microsoft, SAP, JetBrains, JIRA. In case of necessity, supplementary software and computing resources can be purchased on the funds of organizational units;
- A wide range of modelling software solutions used in the industry is used in the implementation of the study course DMI543 Systems Simulation and Modelling Technology and research, including ARENA and SIMUL8as well as the system dynamics modelling tool Vensim.
- Within the study course DMI740 “The Fundamentals of Logistics Information Systems”, development of appropriate competences is ensured with the help of free software and personal data processing and mobile communication tools. The course integrates both hardware and software solutions. Social networking and audiovisual opportunities provided by, for example, Youtube, are used in the study process;
- Open-source software, including Linux, Docker, Kubernetes, Python, R and others, depending on the specifics of the study courses, are widely used. Students can use the local server of Jupyter https://jupyter.vitk.lv/ and public resources for data analysis purposes.
- During the studies, usage of shared resources is promoted, including “GitHub”, “Miro” and

“SharePoint”.

For additional convenience of RTU students, academic staff and employees, RTU leases “Microsoft Windows” and “Microsoft Office” software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail service.

The server technologies are also used within study courses. Students are provided with remote access to specialized software using “Windows terminal services” including “Visual Studio”, “Enterprise Architect”, “SqlServer”, “Eclipse”, “PhpStorm”, “MATLAB R2015b”, “Microsoft Dynamics AX”. More complex tasks are solved using a computer cloud, which consists of 14 servers each having 128GB RAM (DDR4@2400MHz), 2 pcs., CPU (Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz, 8 Core), disk array capacity 120TB and specialized servers. For example, DOP391 Information Systems Management uses two Supermicro servers, which consists of one 8-core processor Intel(R) Xeon(R) CPU E3-1275 v6 @ 3.80GHz, 64GB RAM memory, 1TB SSD disk space and 4TB SATA hard disk size. The second server consists of one 16-core processor Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz, 128 GB operation memory, 2TB SSD disk space and 8TB SATA hard disk size, to let students arrange their isolated work environment computer network security, solutions for design and testing of IT system supervision and management. Both servers have Proxmox VE hypervisor installed and students use “nested virtualization” technology.

In order to provide simple and effective identification of IT users, the IT user identity management system has been introduced, and as a result, each IT user has a unique electronic identity created and maintained, and made valid in all information systems. In addition to the mentioned above, a user session management system in IT systems is provided, where at one single application in RTU information systems, IT users do not need a repeated authorization. This offers the user experience of a joint integrated information system, which remembers various identification data and inputs it again to implement different scenarios of IT application.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalogue of all IT services in the same place.

For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programs (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programs, the study course register (https://info.rtu.lv/rtupub/disc2/list - public part), development of individual study plans, drafting of orders, study courses and training, input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in administration of the study process.

In order to ensure efficient study process, “Moodle” e-learning environment is used, where all binding information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-instructor communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc. On ORTUS portal students can see their financial information, make requests for documents (certificates, academic records, copies of the agreement, etc.). Academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

More than 130,000 unique study course websites have been generated in the RTU e-learning environment since 2007. Students can connect and get access to electronic learning aids at any time and place.

Effective classroom resource management and planning of studies is provided by digitalization of classrooms and time schedules (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or member of the academic staff can see their schedule, specifying places, times, names of lecturers, classroom names and types of classes. To provide users with extra comfort, the system significantly facilitates planning and scheduling of classes, as well as optimizes classroom occupancy and use efficiency.

The Scientific Library of RTU is an academic library of state significance, which has obtained its status as a result of library accreditation. The Scientific Library of RTU provides the necessary information for RTU study process and research activities, performs library, bibliographic and information services for RTU students, teaching staff, and employees. The Library’s collection includes 1.3 million printed documents and e-resources in the databases relevant to RTU fields.

In 2016, significant investment was made in the development of the library infrastructure, with the construction of an additional 2240 m2 of space for the Central Library. The total area of the library premises is 6393 m2, of which 3417 m2 are for reader services. There are 713 workstations for library users. The library has four group rooms and six individual cubicles, a rare edition reading room and a conference room. The library is accessible to users with reduced mobility.

In order to improve the SL activities and to meet the information needs of academic and research staff, the Library Council has been established, which decides on replenishing the library collection with printed publications and subscribing to the necessary databases. The Library Council has approved the Compilation Policy of RTU SL Collection, which sets the basic principles of the collection development in accordance with the areas of RTU academic and research activities.

When RTU provides funding for the library, the funding for information resources for each study program is calculated. The collection is replenished according to the recommendations of the heads of study program, researchers, in compliance with the allocated funding. By contacting the SL Collection Development Department regarding replenishment of collection, the desired editions can be ordered at the Library website by filling out an order form (https://www.rtu.lv/lv/studijas/biblioteka/pakalpojumi-3 (only in Latvian), library's English language web site is https://www.rtu.lv/en/studies/scientific-library), an application form, contacting by phone 67089353, or visiting the Library at 5-105 Paula Valdena Street. The SL offers a guide, which includes websites of various Latvian and foreign publishing houses and bookstores for searching publications and e-resources.

Database subscription agreements are concluded both directly with the supplier and through the Cultural Information Systems Centre, which is the Latvian national representative for the international non-profit organization Electronic Information for Libraries (EIFL http://www.eifl.net/). The EIFL Licensing Program offers libraries of state importance to subscribe to internationally recognized databases at a significantly reduced subscription fee that is not offered to individual subscribers, thus saving the financial resources of the libraries.

Every month, the list of the newly-received literature is published in the SL newly-received literature bulletin (https://www.rtu.lv/lv/studijas/biblioteka/jaunieguvumi (only in Latvian)).

The database subscriptions maintained by RTU Scientific Library (https://www.rtu.lv/en/studies/scientific-library/electronic-resources):

- ProQuest Ebook Central, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, EBSCOhost eBook Academic Collection, Wiley Online Library, SpringerLink, The International Monetary Fund.
- Databases financed by the Ministry of Education and Science available to RTU Scientific Library: ScienceDirect, SCOPUS (Elsevier), Web of Science.
- Latvian databases: LETA, Letonika, the Database of Latvian Standards (available on the premises of the Library).

Database usage at the Scientific Library of RTU has been growing since 2016.

The new library premises have allowed to extend the range of services. Since the opening of the new premises in 2018, the number of visits to the library has increased from 103,825 to 691,200. The Central Library is open to users from Monday to Saturday (https://www.rtu.lv/writable/public_files/RTU_library_general_info_summer_2022.pdf). There is a 24/7 reading room. During the summer period, the Central Library is open every weekday with reduced opening hours.

The SL information sources are provided in the open access. Books and periodicals relevant for the study fields are located in the main building of the Scientific Library (5 Paula Valdena Street) in compliance with UDC indexes. The last copy of the oldest editions that comply with RTU profile is stored in the library repository. They are always available to users.

The on-duty librarian helps find the necessary resources. More detailed information and consultations are provided by bibliographers. The SL has librarians responsible for particular fields of science (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija (only in Latvian)).

Searching for library resources is ensured by the Primo Discovery search tool (https://primolatvija.hosted.exlibrisgroup.com/primo-explore/search?sortby=rank&vid=371KISCRTU_VU1&lang=en_US). It allows searching for the information in the library catalog (https://kopkatalogs.lv/F/?func=find-b-0&local_base=rtu01), subscribed databases, as well as in databases created by the Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/bibliotekas-veidotas-datubazes). Searching for the information in the joint electronic catalog (https://kopkatalogs.lv/F), one can simultaneously obtain information about the available resources in 12 libraries in Latvia. Both the electronic catalog and RTU portal ORTUS can be used to reserve the library resources remotely. Remote access to databases is also provided. Since the introduction of RFID technology, users have been able to use five book-dispensing self-service vending machines and return books to a book-sorting vending machine around the clock. Book usage term can be prolonged remotely.

The SL provides students, academic staff and other stakeholders with different types of individual consultations and group training in information literacy (https://www.rtu.lv/en/studies/biblioteka/lietotaju-apmacibas).

Editions that are not available in the Scientific Library are delivered through an interlibrary subscription or international subscription. Internet access is provided throughout the Library. The SL provides copying, scanning, printing and binding services, there is also a self-service canteen.

The SL can be contacted via: Ask the Librarian, using information e-mail, calling to the information phone number (https://www.rtu.lv/en/studies/scientific-library).

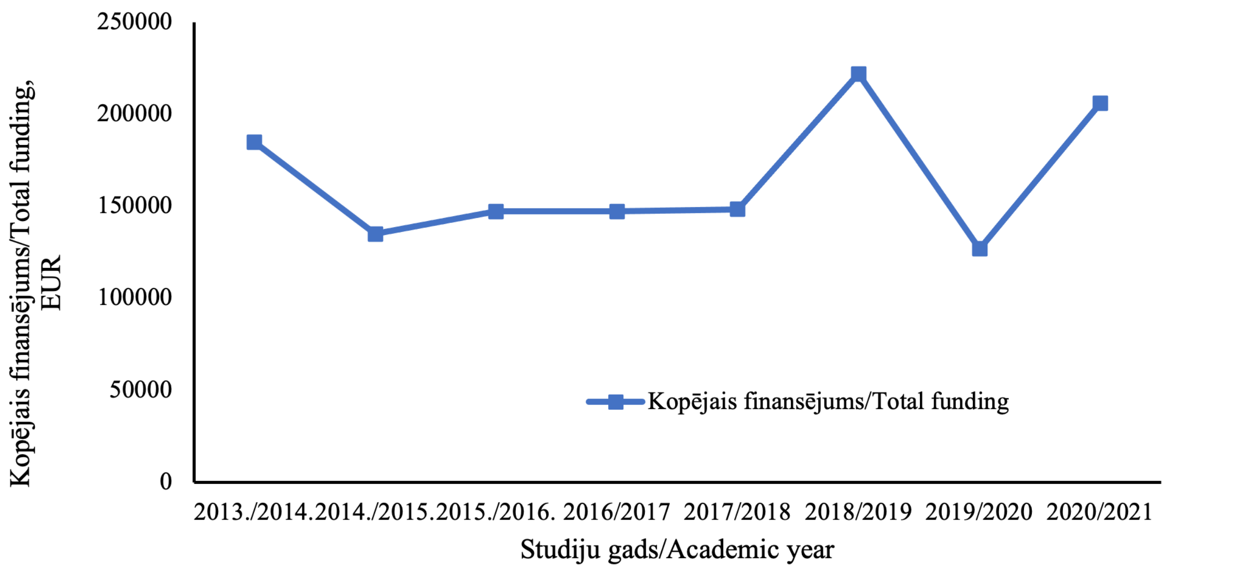
The academic staff are advised to recommend students at least one e-book from the available bibliographic resources.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The study program is financed from the regular budget of the Ministry of Education and Science of the Republic of Latvia and the tuition fees. 100% financing on the study program "Information Technologies" comes from the regular budget of the Ministry of Education and Science, because Information Technologies is a priority program according to employers' recommendations, which is assigned appropriate state budget funding. Distribution of the funding is set out in RTU regulations "On Approval of the Methodology of Distribution and Allocation of Funds to Organizational Units of RTU in Academic Year 2021/2022". They specify allocation of funds for centralized RTU services and organizational units that provide the study courses. The full annual tuition fee is set at EUR 6694,22.

The available funding for the study program is illustrated in the chart. During the reporting period, the study program funding has increased. The increase is conditioned by the growth of funding allocated per one study seat. The fluctuations observed for the past years are associated with fluctuations in the number of students and changes in the allocated funding.



Remuneration (47%) takes the major part of expenses (academic year 2021/2022). Appropriate funding is also allocated to support the infrastructure. Certain funding is planned for purchase of bibliographic resources, although a part of these resources is purchased by RTU (IEEE) or the state (Scopus). Travel expenses make 0%, because of COVID-19 pandemic restrictions on travelling. Equipment modernization costs this year are low, because the equipment was updated before moving to new facilities.

Cost item	Amount	%
Average actual costs per 1 student, EUR	6093.57	100%
Remuneration	2863.46	47%
Employer's SSIC, compensations and benefits	682.45	11%
Business trip expenses	2.89	0%
Payments for services	163.30	3%
Materials, energy resources, inventory	27.03	0%
Purchase of books and magazines	208.01	3%
Purchase and modernization of equipment	70.41	1%
Administration costs *	718.49	12%
Infrastructure costs *	1063.32	17%
Social security costs	294.21	5%

The minimal number of students in the study program that ensures its cost-effectiveness is 40 students in all study years.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

Four professors and 6 associate professors are involved in the implementation of the study program, whose qualifications meet the needs of the study program to the fullest extent. Qualification of the academic staff implementing the study program fully corresponds to the study program implementation conditions and requirements of the regulatory enactments, ensures achievement of the objectives of the study program and relevant study courses, results of tasks and learning outcomes (see the CVs of the academic staff). The study program involves 16 PhD degree holders, and all the academic staff responsible for the study courses hold a PhD in the corresponding field. Short biographies of professors and associate professors involved in delivery of the study program are given below.

Prof. Jānis Grabis – Director of the Institute of Information Technology of RTU Faculty of Computer Science and Information Technology. A co-author of over 125 "Scopus" indexed international scientific publications about the issues related to enterprise integration, optimization and digitalization of project management and business processes ("Scopus" h-index is 12). Prof. Grabis worked as a researcher or a visiting professor at the University of Michigan-Dearborn and Stockholm University; has led and participated in more than 12 scientific research projects, including EC framework programs, ERDF practice-oriented research, LCS (Latvian Council of Science) Fundamental and Applied Research Program, projects of EEA and Norway grant and State Research Program, as well as in more than 10 contracted works in cooperation with the companies. Head of the Bachelor, Master and PhD study programs in Information Technology. In 2021 was recognized as RTU Academic Staff of the Year.

Prof. Jurijs Merkurjevs (Yuri Merkuryev in English) is Full Professor and Senior Researcher at the Department of Modelling and Simulation of the Institute of Information Technology, Riga Technical University, Latvia. He holds Dr.sc.ing. (1984, in Systems Identification) and Dr.habil.sc.ing. (1997, in Modelling and Simulation) degrees, both from Riga Technical University. His professional interests include modelling and simulation of complex systems, methodology and practical application of discrete-event simulation, supply chain simulation and management, as well as education in the areas of M&S and logistics management.

Prof. Merkurjevs is regularly involved into performing research projects in the area of simulation-based sustainable management of complex systems, at both international and national levels. In the academic field, his teaching experiences include courses in discrete-event systems simulation (both introductory and advanced) and supply chain management, as well as performing duties of RTU director of the international Master study program "Logistics and Supply Chain Management" (2012-2020). He has delivered guest lectures and courses at many universities in Europe, Asia and North America, and supervised 10 PhD Theses.

Prof. Merkurjevs is a full member of the Latvian Academy of Sciences, Latvian State Emeritus Scientist, President of Latvian Simulation Society, Fellow of the European Academy for Industrial Management, senior member of the Society for Modeling and Simulation International (SCS), senior member of the Institute of Electrical and Electronics Engineers (IEEE), as well as a member of the International Simulation Team Excellence Network in M&S. He is an associate editor of "Simulation: Transactions of The Society for Modeling and Simulation International", and editorial board member of "International Journal of Simulation and Process Modeling".

Prof. Merkurjevs has authored more than 370 scientific publications, including 52 journal papers, 15 book chapters and 11 books, as well as published 7 text-books.

He is regularly involved in the organization of international scientific conferences in the area of modelling and simulation. In particular, he is serving as a General Co-Chair of the annual International Multidisciplinary Modeling & Simulation Multiconference (I3M), and General Co-Chair of the annual International Conference "Harbour, Maritime, & Multimodal Logistics Modelling and Simulation" (HMS).

Prof. Egils Ginters – Dr.sc.ing. (1996), professor and leading researcher (2016) of the Faculty of Computer Science and Information Technology of Riga Technical University, corresponding member of the Latvian Academy of Sciences (2017), full member of the European Academy for Industrial

Management (2019), member of the board for several IT companies (1991). Senior member of the Institute of Electrical and Electronics Engineers (IEEE), as well as the Vice- President of the Latvian Society for Modelling and Simulation and a member of the European Society for Social Simulation. Fields of scientific research: Modelling of socio-technical and distributed systems and simulation modelling, use of virtual and augmented reality technologies in restoring human resources communication and working abilities, use of digital technologies in logistics information systems. Simultaneous research result validation in private companies is a characteristic feature of research conducted by Prof. Ginters. Significant international scientific research projects: FLAG-ERA FP7/H2020 FuturICT 2.0 (2017-2021), FP7-ICT-2011-7 FUPOL No. 287119 (2011-2015), FP7-ICT-2009-5 CHOREOS No. 257178 (2010-2014), FP6-IST-2002-2.3.2.6 e-LOGMAR-M No.511285 (2004-2006), LdV SocSimNet LV/B/F/PP-172.000 (2004-2006), LdV LOGIS MOBILE LV/B/F/PP-172.001 (2004-2006), FP5-IST BALTPORTS-IT (2000-2003), LdV LOGIS LV-PP-138.003 (2000-2002), EC INCO Copernicus DAMAC-HP PL976012 (1998-2000), EC INCO Copernicus AMCAI 0312 (1994-1997). Published works: Hirsch index – 12; ORCID ID: 0000-0003-2394-6109, scientific articles that have been indexed in SCOPUS ID: 6506734286 - 81, more than 190 scientific publications, 2 patents. Editor of the journal Mathematics (ISSN 2227-7390, MDPI, Q1 cohort) (2021). Reviewer for the journals: Resources, Conservation & Recycling (2020), Energy for Sustainable Development (2020), Journal of Advanced Research (2020), Cities (2018), Technologies (ISSN 2227-7080) (2018), Heliyon (2017, 2018), Symmetry (ISSN 2073-8994) (2017), Journal of Renewable and Sustainable Energy (2017, 2020), Journal of Mathematics, Science and Technology Education (ISSN 1305-8223) (2016, 2017), Information Sciences (ISSN 0020-0255) (2015, 2016, 2018), Computer & Education (2015, 2016), Computational and Mathematical Organization Theory (ISSN 1572-9346) (2015), Mathematical Problems in Engineering (ISSN 1563-5147) (2015) and others. EC H2020 Framework program expert (2020-2021). Pedagogical work: supervised more than 40 Master Theses and 2 PhD Theses that resulted in obtaining a doctorate.

Professor Oksana Ņikiforova obtained a doctorate in engineering. She has a long-term academic work experience, delivering lectures and practical classes within the study course "Object Oriented Systems Analysis". In her capacity of a systems analyst and product owner with the experience in the industry, she helps students develop competencies in object-oriented systems analysis both in modern perspective and showing students the historical development of the methods and documentation of systems analysis in different types of projects and software development tasks of different level of abstraction. Her extensive experience in the management of research projects, student-initiated software development projects and industrial product development projects and participation in their implementation ensure her competence to participate in the implementation of the course "Object Oriented Programming Practice (study project)", organized as small software development projects using object-oriented technology as one of the means of project implementation.

Prof., Dr.habil.sc.ing. Gaļina Merkurjeva has been working at RTU since 1974. From 2002 to 2021, she was a professor at the Department of Modeling and Simulation of the Institute of Information Technology. In 2004, she was awarded the title of RTU Professor, and in 2019 - the title of RTU Professor Emeritus. She was an Honorary Visiting Professor at the University of Ljubljana (2005-2010, Slovenia), underwent internship at Åbo Akademi University, DataCity Research Center (10 months, Turku, Finland). She published 205 scientific publications, including 7 books and more than 20 scientific articles in internationally recognized journals, including Fuzzy Sets & Systems, the European Journal of Operational Research, Simulation, the International Journal of Computational Science (Scopus h-index is 11, and Web of Science h-index is 9). Prof. Merkurjeva managed and participated in more than 25 research projects, including 17 international research projects. In 2014, results of her research were included in the list of the most significant achievements of the Latvian science named by the LAS. In 2017, she was awarded the title of RTU Honorary Employee.

In 2021, she was awarded the title of State Scientist Emeritus was awarded.

Assoc. prof. Andrejs Romānovs – Dr.sc.ing., associate professor and leading researcher at RTU Institute of Information Technology, Head of the Department of Modelling and Simulation, Head of RTU Master study programs "Logistics System and Supply Chain Management" and "Cybersecurity Engineering". 20 years of pedagogical experience in delivery of numerous study courses at Riga Technical University and more than 30 years of professional experience in IT. Co-author for more than 100 international scientific publications in the fields of information technology modelling, cybersecurity, logistics and supply chain management, 58 of which are indexed in Scopus data base (Scopus h-index is 9). Organized more than 30 international scientific conferences and took part in implementation of several scientific research projects in Latvia and internationally. A member of councils and associations in several fields: LCS expert in the field of Information Technology, member of RTU FCSIT Council, member of RTU ITI Council, member of the Latvian Society for Modelling and Simulation, senior member of the Institute of Electrical and Electronics Engineers (IEEE), member of Information Systems Audit and Control Association (ISACA); member of academic networks – IBM Academic Initiative, SimFlex for Academics, Palo Alto Networks, Pearson Higher Education Network, Check Point Secure Academy.

Assoc. Prof. Jeļeļena Pečerska - an educator at RTU FCSIT Department of Modelling and Simulation. Co-author of 13 international scientific publications indexed on Scopus data base on the theoretical aspects of simulation, use of Montecarlo methods, business process digitization, intellectual process analysis matters (Scopus h-index 2). Took part in 4 international scientific research projects, academic conference organization committees, supervised Bachelor and Master theses in information technology.

Assoc. prof. Jānis Kampars – Member of the Board of the Latvian Open Technology Association, Latvian representative in the group of independent experts of the EC *Destination Earth* initiative. A co-author of more than 30 international scientific publications on cloud computing, horizontally scalable real-time data processing systems, digital transformation indexed in Scopus database (Scopus h-index is 6). Actively cooperates with the Union of Local Governments of Latvia, Riga Planning Region, Riga and Kuldiga Municipalities, the Ministry of Environmental Protection and Regional Development, Latvian State Roads, Latvian Road Maintenance Authority and Latvian companies in the issues of digital transformation, open source and open data promotion, use of digital twins. Assoc. prof. Kampars uses the established cooperation network to enhance the study process. Participated in the implementation of more than 9 research projects.

Assoc. prof. Arnis Lektauers, Dr.sc.ing. – RTU Institute of Computer Science and Information Technologies, Department of Modeling and Simulation, Associate Professor and Leading Researcher. A co-author of more than 45 international scientific publications on high-performance interactive computer simulation solutions for complex systems. Participated in more than 10 scientific research projects, including EC Framework Program, EEA and Norwegian grants, National Research Program projects, as well as implemented more than 5 contracted works in cooperation with the enterprises. Along with academic and scientific experience, he has 26 years of professional experience in local and international IT companies. He has been a member of the Modeling and Simulation Group of the NATO Science and Technology Organization since 2011.

Asoc. prof. Inese Poļaka is the author of more than 40 publications indexed in the SCOPUS and Web of Science databases (h-index: 7). Her main research interests include application of machine learning in medicine and analysis of medical data, induction of explanatory machine learning models and data-centric machine learning. She participated in Horizon Europe and local research projects in data science and machine learning, data analysis and management, and open and responsible science activities.

Nine members of the academic staff who work in the fields of Engineering and Technology - Electrical Engineering, Information and Communication Technology or Natural Sciences - Computer Science and Informatics are included in the expert database of the Latvian Council of Science.

Name	Surname	ORCID	Scientific field(s)	Election term
Ludmila	Aleksejeva	0000-0003-0900-3868	Engineering and technology - Electrical engineering, electronics, information and communication technology	18.09.2022
Jurijs	Merkurjevs	0000-0001-7178-5640	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Inese	Poļaka	0000-0002-9892-7765	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Egils	Ginters	0000-0003-2394-6109	Engineering and technology - Electrical engineering, electronics, information and communication technology	31.03.2024
Jānis	Grabis	0000-0003-2196-0214	Engineering and technology - Electrical engineering, electronics, information and communication technology	05.01.2025
Arnis	Kiršners	0000-0002-1252-0623	Natural sciences - Computer science and informatics	18.11.2022
Andrejs	Romānovs	0000-0003-1645-2741	Natural sciences - Computer science and informatics	25.05.2023
Jānis	Kampars	0000-0003-0045-5593	Natural sciences - Computer science and informatics	04.11.2023
Sergejs	Paršutins	0000-0002-8689-3043	Engineering and technology - Electrical engineering, electronics, information and communication technology	07.10.2023

Members of the academic staff have been engaged in the professional advancement program. Henrihs Gorskis did an internship at the University of Buffalo (USA). Darja Plinere participated in SAM 8.2.2. specific objective project “To Strengthen Academic Staff of Higher Education Institutions in the Areas of Strategic Specialization '', within the project, she obtained a PhD degree and continued her academic activities in the study program. The academic staff in the program possess advanced digital skills. Assoc. prof. A. Romānovs received the RTU award for the best e-learning courses.

High qualification of the academic staff is evidenced by the fact that they are invited to work at foreign universities. For example, Jānis Grabis has been a visiting professor at the University of Stockholm and an expert at the University of Rostock. Prof. Merkurjevs delivered guest lectures at:

- Hasselt University, Belgium, in April 2014, the lecture “Analysis and management of anchored supply chains in simulation modelling”;
- Tashkent Automobile and Road Construction Institute, Uzbekistan, in May 2015, the lectures

“Modern information technologies in supply chain management” (to professionals in the field) and “Analysis and management of anchored supply chains in simulation modelling” (to students);
- Bukhara State University, Uzbekistan, in May 2015, lecture “Analysis and management of anchored supply chains in simulation modelling”;
- Old Dominion University, Norfolk, Virginia, USA, on 24 March, 2016, the lecture "Simulation-Related Education and Research: Experiences at the RTU Institute of Information Technology, Riga, Latvia";
- Vel Tech Technical University, Chennai, India, on December 4-5, 2018, the intensive course “Logistics and Supply Chain Management” 4.0 to MBA student (together with A. Romānovs).

ERASMUS program plays a significant role in qualification improvement. For example, Assoc. Prof. A. Romānovs participated in the academic exchange programs at the Autonomous University of Barcelona, Spain (in 2021, 2019, 2018), Vilnius Gediminas Technical University, Lithuania (in 2019), Chennai Vel Tech University, India (in 2018). Development of further cooperation occurs in the framework of EUt+ program. The academic staff also actively participate in the activities of international professional societies, for instance, IEEE, ACM and IFIP, which promotes experience exchange with world leading experts in the field.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, renewal of the academic staff has been considered as one of the tasks, which has been completed upon replacement of retiring colleagues with new qualified academic staff. Starting with the academic year 2016/2017, the average age of the academic staff at the program was 49,8 years, but since the academic year 2021/2022 it has been 47,7 years. Generally, the academic staff during the reporting period is estimated as stable. During the reporting period, several associate professors, e.g., Assoc. Prof. Jānis Kampars (2018) and Assoc. Prof. Inese Poļaka (2020) were elected for the first time. In 2016, a young professor Egils Ginters stated working at the study program. Three professors retired in the reporting period. Generally, during the reporting period the number of professors decreased as a result of generation change, but the number of associated professors, who previously occupied positions of assistant professors, increased. The total number of involved responsible academic staff during the reporting period was stable.

Year	Professors	Assoc. professors	Assist. professors	Lecturers and assistants
2013/2014	5	5	5	3
2021/2022	4	6	3	4

Distribution of the academic staff corresponds to the needs of the study program. The proportion of the involved professors and associated professors meets the trends observed at the leading universities around the world. The studies involve a greater number of assistants, who help students individually at practical classes.

3.4.3. Information on the number of the scientific publications of the academic staff

members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Scheduling of the study courses ensures successive acquisition of knowledge; the curricula of the study courses are coordinated. Descriptions of the study courses specify the necessary preliminary knowledge and study courses to be acquired previously. Cross-referencing among the study courses is the matter of regular discussions at academic departments, which are coordinated by the Head of the study program. The experience exchange amongst the academic staff is promoted at the methodological seminars organized by FCSIT and ITI.

The study courses are complementary. The study course DOP715 Reliability of Information Systems covering technical aspects of reliability well coordinates with DMI744 Information Technology Governance in the overall context of IT governance. DMI548 Design of Management Information Systems considers the basics of design that are used within DOP723 Digital Transformation to explore promising digitalization solutions. DOP723 also applies the methods acquired within DMI728 Data Mining and Knowledge Discovery for big data use in digitalization and data analysis in research. The study course DMI543 Systems Simulation and Modelling Technology ensures acquisition of experimental methods for use in other study courses. In the second year of studies, the study courses strengthen the knowledge acquired in the first year.

The current student to staff ratio is 8, which is in compliance with the average level among the leading universities around the world.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DMI0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DMI0(45526)_Dipl_LV_Dipl_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DMI0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DMI0(45526)_AIP_atzinums250stud_Inform_tehnol.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DMI0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DMI0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMI0(45526)_AtbilstibaValstsStandartam_AkadMag_EN.pdf	P06_3.2.1_DMI0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DMI0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DMI0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DMI0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DMI0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DMI0(45526)_StudyCoursesdescr_ENG.zip	P10_DMI0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Intelligent Robotic Systems (43526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Intelligent Robotic Systems*
Education classification code	*43526*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Agris*
Surname of the study programme director	*Ņikitenko*
E-mail of the study programme director	*Agris.Nikitenko@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089550*
Goal of the study programme	*The aim of the academic Bachelor study programme “Intelligent Robotic Systems” is to prepare professionals who can be characterized by ability to think systematically, to analyze, develop and implement technically and economically reasoned robotic and intelligent system solutions that promote application of these solutions to ensure organizations’ labor productivity increase and growth, as well as to develop the student’s ability to carry out scientific work, to participate in local and international projects and to continue studies at Master and Doctoral study programmes.*
Tasks of the study programme	*To achieve the aim set several tasks of the study programme are defined, as well as indicators of their fulfillment. They are reflected in the Table below: 1)To develop students’ systems thinking ability and practical skills that are necessary for development of the technically and economically reasoned robotic and intelligent systems solutions 2)To use in the study process both fundamental and classical solutions and the latest achievements in robotics and artificial intelligence. To promote students' individual and practical work, as well as direct communication and work in groups 3)To provide knowledge and experience provision for students in several areas by cooperation with teaching stuff from different departments of Riga Technical University (RTU) 4)To assure the flexibility of the study program and the possibility to modify it in order to follow changes in the labor market and new developments in Information and Communication Technology (ICT) 5)To prepare and motivate students for their Master studies 6)To ensure learning outcomes defined for the program listed below 7)To develop cooperation with similar or topic-related programs in other countries within ERASMUS and other agreements*

Results of the study programme	*According to the learning outcomes defined for the "Intelligent Robotic Systems" study programme, the graduates of the programme will:* *1) be able to formulate a specific problem in terms of automated and robotic systems;* *2) be able to develop solutions to particular problems by using modern automatic and electric drive elements;* *3) be able to develop an automatic or robotic system's control algorithm;* *4) be able to develop software for a specific robotic or automatic equipment management and coordination;* *5) be able to develop solutions that combine hardware and software technology advantages;* *6) know how to distinguish problems that should be solved with the hardware resources from those which should be solved with software resources;* *7) know how to identify problems that can be solved with intelligent robotic systems;* *8) be able to independently acquire new knowledge and skills;* *9) be able to work in group to achieve common goals;* *10) be able to substantiate the specific solution's advantages or disadvantages to the customer or to another professional;* *11) be able to provide compliance to professional and general ethic rules within their scope of authority;* *12) be prepared for their Master studies.*
Final examination upon the completion of the study programme	*The results evaluation system is based on RTU Learning Outcomes Evaluation Regulations (Minutes no. 539) approved on March 29, 2010. The evaluation methods for each subject are defined by the responsible academic personnel (teacher) according to study course goals, tasks and applied teaching methods. The evaluation methods are known to students at the beginning of the semester. Some of the evaluation methods used by teachers are as follows:* *1) written or oral examinations during the session;* *2) written or oral individual work, the learning outcomes of which can include a presentation;* *3) project that can be evaluated according to the student's contribution to group work;* *4) regular tests during semester;* *5) combination of the previously mentioned methods;* *Assessment of each subject is determined according to 10 grade scale or in case of the test with the* *pass/fail.* *Bachelor Paper is also evaluated according to 10 grade scale.*

Study programme forms

Full time studies - 3 years - latvian

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*120*

Admission requirements (in English)	*General or vocational secondary education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Intelligent Robotic Systems*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The title of the study program, the degree to be obtained, the stated aims, objectives, implementation methods, learning outcomes and admission requirements of the study program are mutually consistent and relevant. The study program is implemented in the form of full-time intramural studies in Latvian. In accordance with the pillar of academic excellence formulated in the RTU Strategy, the quality management of the study program is comprehensive and continuous, requiring changes in the curriculum, form of implementation or other aspects of the program in each academic year. During the reporting period, changes have been made through the introduction of new courses, the development of existing courses, changes of lecturers (for various reasons) or other actions related to the quality management of the program.

Nevertheless, the changes in the program parameters are related to the changes in the classification codes of the study programs in the country (Cabinet Regulations No 322 "Regulations on the classification of Latvian education " of 13 June 2017):

- During the previous accreditation period, study program code was 43481 - Information Technology, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science, with the degree “Bachelor of Engineering in Computer Control and Computer Science”.
- Currently, the program code is 43526 - Other engineering sciences with the degree to be awarded “Bachelor of Engineering Science in Intelligent Robotic Systems”.

The changes were implemented due to the fact that, according to the current classification, the field of Computer Science is currently partially included in the field of Computing (48), but the fields of Robotics and Artificial Intelligence, which are at the core of this study program, cannot be included in Computing (482 - Computer Applications, 483 - Computer Systems, Databases and Computer Networks, 484 - Programming). It is therefore necessary to change the code to the above in order to reflect as accurately as possible the nature and content of the study program.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program is included in the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which comprises a range of study programs that focus on the application of technology and scientific knowledge specific to the field in the study process.

The title of the study program "Intelligent Robotic Systems" points at the synergy between two characteristic areas of modern science - Robotics and Artificial Intelligence, which is also manifested with regard to its curriculum, making the study program highly interdisciplinary. According to the current OECD classification of sectors, Artificial Intelligence is included in the field of natural sciences (Section 1), while Robotics is in the field of engineering (Section 2). According to the education sector classification used during the previous accreditation period, both fields correspond to engineering science (see Section 3.1.1 for details). The classification code of the currently foreseen program is 43526 - Other engineering sciences with the degree to be awarded "Bachelor of Engineering Science in Intelligent Robotic Systems".

The goal of the program is to educate and train specialists who have the ability to think systematically, analyze and develop technically and economically sound solutions for robotic and intelligent systems, promoting the growth of productivity and advancement of organizations that use these solutions, as well as to create interest in science for further studies at the Master's and PhD programs.

In accordance with the development trends of modern robotics, the mutual enrichment of the existing automation techniques and technologies with the achievements of the field of artificial intelligence play an increasingly important role, which allows switching to increasing autonomy systems in practically all areas of human activity. Therefore, although the program is interdisciplinary, its backbone consists of engineering study courses, which defines the program as belonging to the field of engineering as a whole. This is analyzed in more detail in section 3.2.1 "Content analysis of the study program". It should be emphasized that, in addition to the compulsory courses, compulsory elective specialization study courses in the volume of 20CP all fall within the field of engineering.

The study program is implemented only in Latvian, as a full-time intramural study program in the volume of 120CP (3 study years). The study program is implemented in cooperation with three RTU faculties: the Faculty of Computer Science and Information Technology, the Faculty of Electrical and Environmental Engineering and the Faculty of Mechanical Engineering, Transport and Aeronautics. It is necessary because robotic systems are a combination of mechanics, electronics and software.

In order to ensure the necessary level of preparedness for studies at the academic Bachelor's study program "Intelligent Robotic Systems", students should meet the following entry requirements:

Basic requirements:

The applicants should have completed general or vocational secondary education to be enrolled in the academic Bachelor study program "Intelligent Robotic Systems".

Additional requirements:

To enter the study program "Intelligent Robotic Systems", the student must have studied physics, chemistry, algebra and geometry in accordance with the requirements of secondary education.

It can be seen that students are admitted to this program depending on their level of preparedness and relevance to the content of engineering studies. Therefore, it can be argued that the title, classification, content, admission requirements and actual implementation of the program are mutually consistent and fit well into the field of study.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

According to the study “World Robotics 2021 Industrial robots – executive summary” (Executive_Summary_WR_Industrial_Robots_2021.pdf (ifr.org)) on the market trends for industrial robots, it can be concluded that despite the effects of the pandemic, 2020 was the third best year ever, falling behind only 2017 and 2018. The most significant increase is observed in the electronics and automotive industries, which have historically been the most highly automated industries in the world. In total, in 2020, the largest ever number of installed robots was reached – approx. 3 million. Although the largest markets for robots are in Asia and the United States, European countries still maintain significant annual growth of 6%, which is faster than the overall economic growth of approx. 3%. This indicates structural changes in the economy and a gradual increase in efficiency in the future. This, in turn, will increasingly boost demand for engineers and service personnel in the relevant field. The growth trend is faster than the forecast at the time of the previous accreditation report, when an average of 4% growth was projected for the EU (“Executive summary 1. World Robotics 2011 Industrial Robots”; data on industrial robots, quoted from: http://www.worldrobotics.org/uploads/media/2011_Executive_Summary.pdf).

Over the next decade, the number of industrial robot installations is expected to grow at an average annual rate of 8% in the EU countries and up to 17% in the Asian countries.

Latvia and the Baltic States as a whole will not be left out of this trend, as it is already evident that Latvian companies are investing much more in production automation and artificial intelligence applications in the wake of the pandemic crisis. Companies such as Ltd Robotic Solutions, Ltd Asya, SIA Giraffe, Ltd Playgineering, Ltd Winmill, Ltd RobotNest have emerged, demonstrating rapid development of the field in Latvia. Also, the well-known companies LMT, Accenture, TET, SAF Tehnika, Riga Smart IOT, etc. have focused on the development of various artificial intelligence, robotics and automation-based solutions.

This attests the need to train in the near future specialists with the skills to operate existing and develop new production automation systems, including robotic systems.

In the process of obtaining the license for the program, support was obtained from the Association of Mechanical Engineering and Metalworking Industries of Latvia, the Latvian IT Cluster, the Latvian Ministry of Defence and the Latvian Association of Computer Technologies.

Currently, apart from the above-mentioned companies, which are the main providers of jobs for the program graduates (Ltd Asya and SIA Robotic Solutions, Ltd Playgineering, Ltd Giraffe are graduate-founded companies), automation companies such as ABB Latvija, Schneider, Peruza and others are active players in the labor market and jointly compete to attract study program graduates.

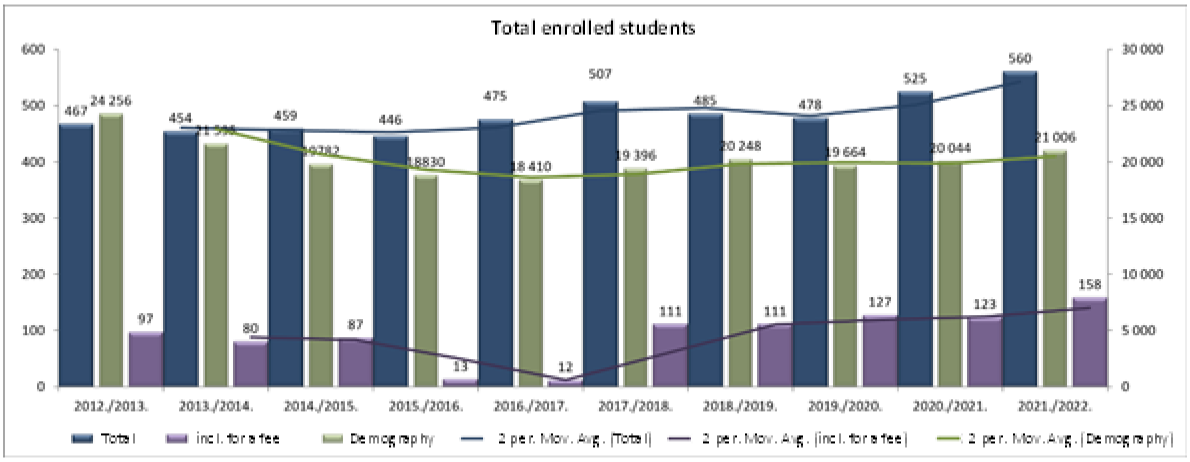
RTU is also a player in the labor market and annually recruits students and graduates for research projects, thus fostering professional development of the graduates and continuation of their research careers. According to the employment statistics of the graduates, all graduates are employed in the fields related to robotics or ICT.

In general, RTU ranks 201st-250th according to the QS Graduate Employability Rankings 2020, which is considered to be a very good indicator in the global context as well.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of

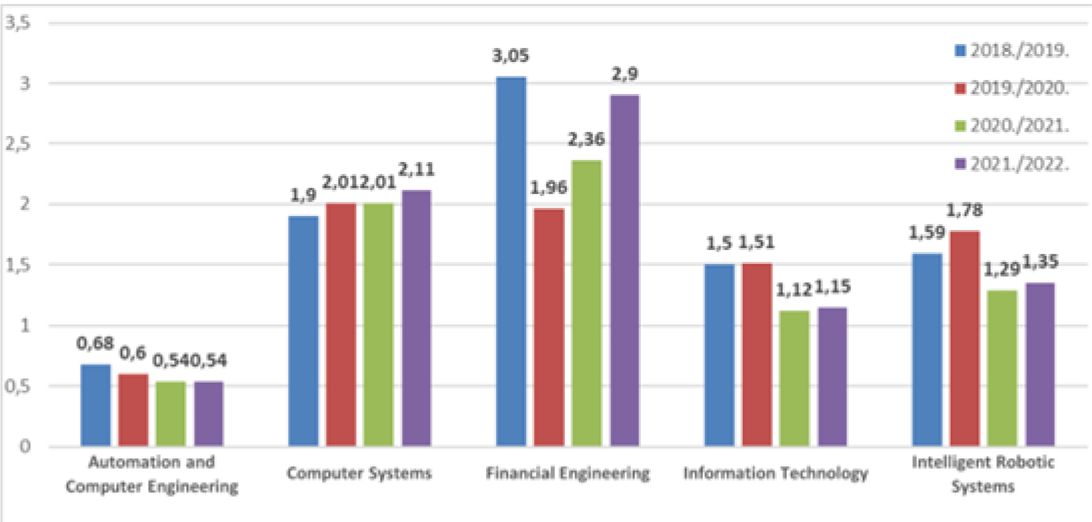
the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Student dynamics at the study program is strongly linked to the overall processes in the sector and to the demographic processes in Latvia as a whole. In the graph below, the total number of students enrolled in the Faculty of Computer Science and Information Technology can be observed in comparison with the demographic dynamics of Latvia (number of secondary school graduates available on the study market), as well as the demand for tuition fee funded study seats:

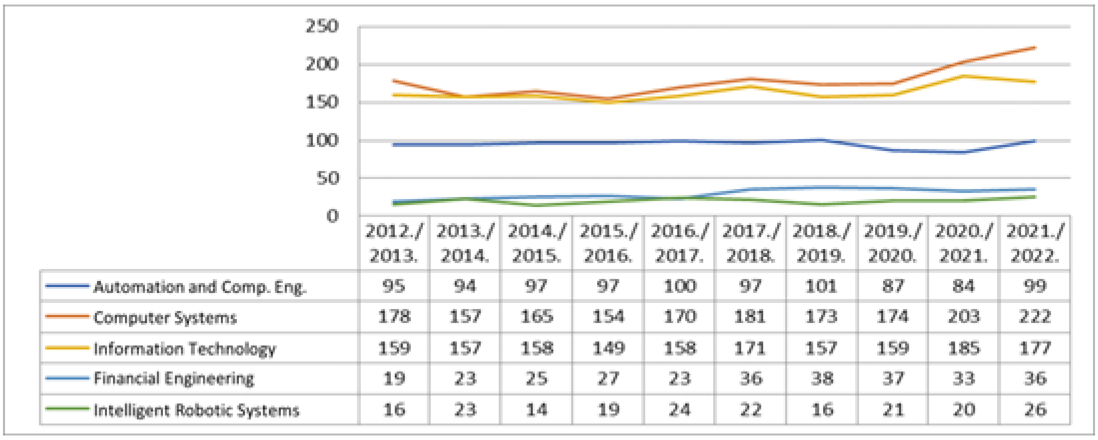


From the graph presenting the total number of enrolled students, it can be seen that in the field of the study program there is a positive trend in the growth of student numbers, both in terms of state budget funded and fee-paying students, which is very much in line with the overall development of the sector and trends in demand for specialists in the labor market.

It is also important to underline the relatively high competition for study seats, as shown in the following graph:

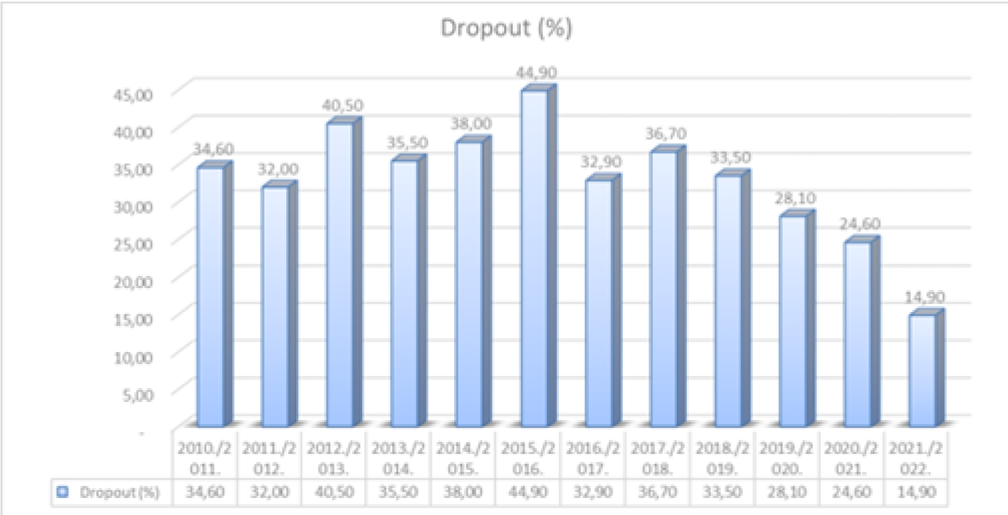


The graph shows that the competition for admission to the program is relatively high, with a growing trend in the last two years after a decline. The program management considers that the drop is due to a failed student recruitment strategy implemented during the period, which is in line with trends observed in other programs. The enrolment figures are given below:



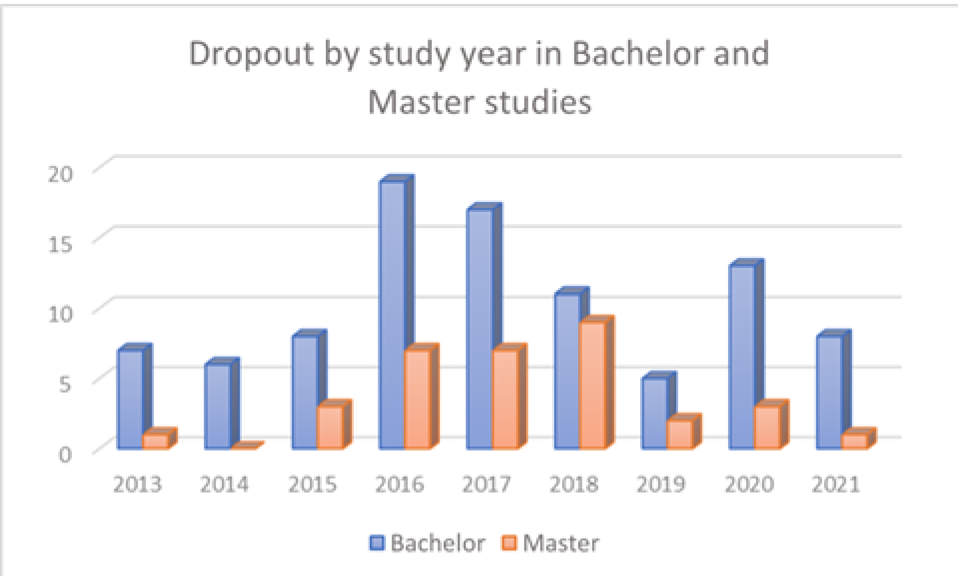
	2012./2013.	2013./2014.	2014./2015.	2015./2016.	2016./2017.	2017./2018.	2018./2019.	2019./2020.	2020./2021.	2021./2022.
Automation and Comp. Eng.	95	94	97	97	100	97	101	87	84	99
Computer Systems	178	157	165	154	170	181	173	174	203	222
Information Technology	159	157	158	149	158	171	157	159	185	177
Financial Engineering	19	23	25	27	23	36	38	37	33	36
Intelligent Robotic Systems	16	23	14	19	24	22	16	21	20	26

The number of enrolled students generally demonstrates a stable trend, which allows for a relatively stable planning of the program development also in the next accreditation period. Overall, the improvement in the dynamics of the drop-out rate should also be highlighted, which follows the overall trend of the Faculty and largely reflects the positive impact of quality management measures on the general trend:

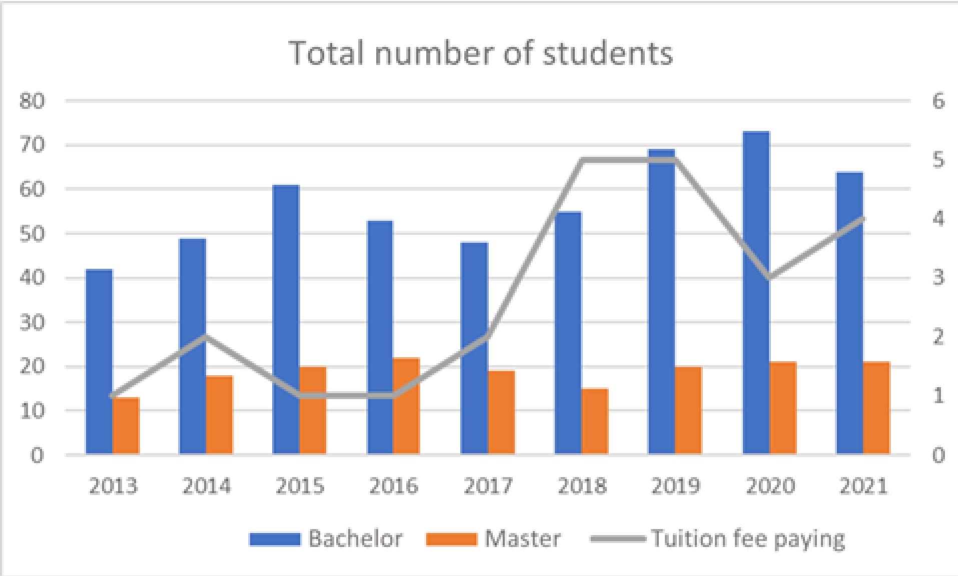


	2010./2011.	2011./2012.	2012./2013.	2013./2014.	2014./2015.	2015./2016.	2016./2017.	2017./2018.	2018./2019.	2019./2020.	2020./2021.	2021./2022.
Dropout (%)	34,60	32,00	40,50	35,50	38,00	44,90	32,90	36,70	33,50	28,10	24,60	14,90

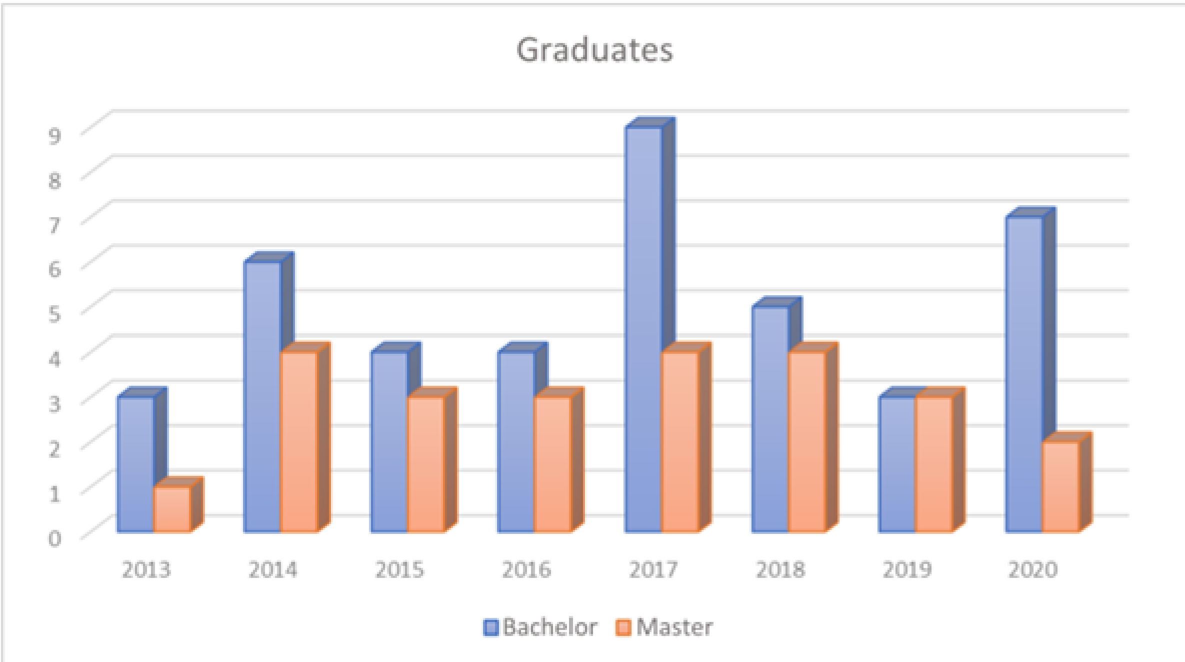
It can be observed that the exmatriculation dynamics (relative) is positive and is a result of the appropriate program management decisions. Specific dynamics in the program:



The study program is strongly related to continuation of education at the Master's level, so it is valuable to observe the trend also in relation to the trends in the Master's program. It can be seen that the drop-out dynamics is generally positive in the corresponding Master's program as well, which generally reflects sound program management measures for student retention. As a result of these decisions, an increase in the total number of students in the programs can also be observed. Moreover, this trend continues in the Master's programs and in tuition fee covered programs, which have shown some albeit modest growth in recent years.



In terms of graduates, the program suffers somewhat from the inertia of the measures taken, as shown in the graph below:



The alumni dynamics in general indicates the need to continue the positive changes in the program governance, which already has a positive impact on Bachelor program graduates (a clear increase in academic year 2020/2021), but due to the mentioned inertia in the Master program, changes are still expected.

In general, the study program holds a good overall position in terms of quality and demand among other programs, as well as demonstrates a number of positive trends reflecting the impact of management on student retention and the introduction of a more personalized approach to student motivation in daily work.

Statistical data on the Bachelor study program "Intelligent Robotic Systems" are also presented in the Annex P05_3.1.4_DBR0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The aims, objectives, curriculum design and implementation methods of the study program are in line with the current trends in the industry, technology and sustainable management. The total volume of the study program is 120 CP, of which 87 CP are compulsory study courses and the rest are compulsory elective and free elective study courses. Based on program specifics, all study courses may be categorized into the following interrelated thematic groups:

- **Fundamental subjects of engineering sciences**

  Compulsory study courses: Mathematics (including additional units), Physics, Theoretical Mechanics (robotic systems), Discrete Mathematics, Probability Theory and Mathematical Statistics, Numerical Methods, Random Processes, Introduction to the Study Field, Fundamentals of Graphics Communication;

- **Study courses of general education**

  Compulsory study courses: Languages (English, German), Fundamentals of Computer Graphics and Image Processing, Civil Defence, General Sociology, Innovative Product Development and Entrepreneurship;

- **Electronics and related fields**

  Compulsory study courses: Introduction to Computer Architecture, Electrical Engineering and Electronics, Embedded Systems, Basics of Signal Theory, Industrial Electronic Equipment;

- **Fundamentals of robotic systems**

  Compulsory study courses: Robot Kinematics, Traction Drives of Electrical Transport, Special

Purposes Electrical Machines, Control Technique with Microprocessor Controllers, Basics of Computer Control, Linear and Nonlinear Systems;

- **Software development**

  Compulsory study courses: Data Structures, Algorithmization and Programming of Solutions, Object-Oriented Programming, Programming Language C++ for Controllers Management;

- **Intelligent control systems**

  Compulsory study courses: Discrete Structures of Computer Science, Fundamentals of Artificial Intelligence, Intelligent Electronic Equipment in Robotic Systems;

- **In-depth knowledge segments**

  This group of study courses is made up of compulsory elective study courses in humanities and social sciences, pedagogy or economics and management, and free elective study courses.

- **Specialization study courses**

  This group is made up of compulsory elective study courses that allow students to choose between two specialization areas:

  Robotic hardware:

  - Introduction to Digital Electronics;
  - Electric Drive of Robots;
  - Introduction to Electrical Drives;
  - Robot Control Systems;
  - Power Electronics;
  - Electrical Drives (Study Project);

  Robot control:

  - Robot Systems Modeling Basics;
  - Basics of Autonomous and Mobile Robotic Systems;
  - Foundations of Computer and Robotic Systems Design;
  - Logical Foundations of Intelligent Robots;
  - Robot Control System Development Project;

These thematic groups are not fixed modules of the study program. The subjects of the study program may be organized in several module systems to ensure flexibility in meeting the requirements of the labor market and, if needed, cooperation with similar study programs of universities in other countries.

Distribution of study courses by time and volume is given in the Table below:

Part	**Study course group**	**CP**
A	Compulsory study courses	**87**
B	Compulsory elective study courses	**19**
	1. Specialization study courses	**14**
	2. Study courses in humanities, social sciences, pedagogy or economics and management	**5**

C	Free elective study courses	**4**
D	Bachelor Paper	**10**
	Total	**120**

The aim of the study program is to educate and train the specialists capable to think systematically, analyze and develop technically and economically sound solutions for robotic and intelligent systems, promoting the growth of productivity and advancement of organizations using these solutions, as well as to create interest in science for further studies in the Master's and PhD programs.

In order to achieve the aim, several tasks of the study program have been defined, as well as the characteristics of their implementation. They are shown in the following table:

No	Task	Performance indicators
1.	To develop students' systems thinking ability and practical skills that are necessary for development of the technically and economically reasoned robotic and intelligent systems solutions;	In order to promote students' ability to think and perceive robotic systems in their unity, the following study courses have been introduced: Robot systems modeling basics, Basics of autonomous and mobile robotic systems, Industrial robot control systems, as well as Robot Control System Development Project.
2.	To use in the study process both fundamental and classical solutions and the latest achievements in robotics and artificial intelligence. To promote students' individual and practical work, as well as direct communication and work in groups;	The study program includes several fundamental study courses that provide the necessary fundamental knowledge and skills for work and further education in the field of engineering, including mathematics and its additional chapters, probability theory and its additional chapters, physics, electrical engineering and electronics, etc. Study courses, which form the basic knowledge framework in the field of robotics have been included, including Theoretical Mechanics (robotic systems), Robot Kinematics, Special Purpose Electrical Machines, Industrial Electronic Equipment, Basics of Signal Theory, Electric Drive of Robots, Microprocessor Technology, etc. Independent and practical work is promoted through practical work within the study courses, as well as with the help of dedicated courses, for example, "Robot Control System Development Project."

3.	To provide knowledge and experience provision for students in several areas by cooperation with teaching staff from different departments of RTU;	The study program is implemented in cooperation with three faculties: Faculty of Computer Science and Information Technology, Faculty of Electrical and Environmental Engineering, Faculty of Mechanical Engineering, Transport and Aeronautics. This ensures the provision of knowledge and experience in the relevant areas of the program to students. In addition to the above said, students are invited to choose topics for their graduation papers that focus on one of these areas.
4.	To assure the flexibility of the study program and the possibility to modify it in order to follow changes in the labor market and new developments in technology;	The study program includes both compulsory and elective study courses, and students can select a combination of the study courses, which allows them to adjust their curriculum according to own wishes and market requirements. Students have an additional opportunity to take advantage of the cooperation with the University of Tartu, which lets students increase the flexibility of the program and its capacity to adapt to specific changes in the labor market, industry, or student demand.
5.	To prepare and motivate students for their Master studies;	In order to prepare students for Master studies, a study project has been introduced, which raises interest in the field as a whole and creates desire to advance in this field. Extracurricular seminars conducted by Master and PhD students are organized, in such a way, stimulating the work at the RTU Robotics Club or Robotics Prototyping Laboratory. It allows students to improve their skills by participating in international robotics competitions.
6.	To ensure achievement of the learning outcomes defined for the program listed below;	The following learning outcomes of the study program are achieved by combining the knowledge and skills obtained within the compulsory and elective study courses with the practice gained during laboratory works and projects, as well as by developing research skills in the graduation paper development process. Thus, the combination of the learning outcomes of separate study courses ensures the fulfillment of the common aims and tasks of the study program.

7.	To develop cooperation with similar or thematically related programs in other countries within ERASMUS and other agreements.	An ERASMUS cooperation agreement has been signed with the University of Tartu (attached as an additional appendix). Such ERASMUS + study development projects as IOT.OPEN.EU and Autonomian have been implemented, which have allowed supplementing the curriculum and include definite thematic blocks for content improvement in the study courses.

According to the mapping of the learning outcomes of the study program, it can be concluded that all learning objectives are being met. Given the rapid changes in the field, changes have been introduced to the program during the accreditation period, affecting both general and specialization study courses. The major changes concern the study of Innovation and Entrepreneurship, which has the volume of 4CP and involves working closely in groups to learn the processes inherent in the creation and implementation of innovations. Changes have also been made to the teaching methods, using the experience of the lecturers gained during the in-service training in the USA (University of Buffalo), in which 5 lecturers of the study program participated - A.Ozols, K.Berkolds and M.Uhanova, K.Bočko, A.Anohina-Naumeca. This has allowed to significantly improve student feedback on the implementation of specific courses, as well as to introduce modern teaching methods. For example:

- The “Introduction to Study Field” course introduces a practical component where students complete the full development cycle of their first robot prototype, which, although simplified, gives a good idea of the development life cycle of robotic systems. The practical work is carried out in the Robotic Prototyping Laboratory of the Faculty of Computer Science and Information Technology, which also allows students to see experienced researchers working on research projects in the field of robotics.
- Similarly, the course "Robot Control System Development Project" focuses on creating new robots or improving existing robot control systems using artificial intelligence techniques. In this case, existing robots in the Robot Prototyping Laboratory such as Baxter, ABB IRB 1600, ABB 1200, Aldebaran / Softbank robotics Pepper, Jaguar and others are used for the development of control and sensor systems.
- The course "Algorithmization and Programming of Solutions" has introduced a substantial practical work section, which has contributed to improvements in grades and student motivation.

Changes have also been made in other courses to complement existing methods where possible with practical experience tasks, thus increasing student motivation and relevance to the requirements of the field.

Several continuous quality assurance and management activities are carried out to update study courses according to the needs of the industry. They include the active participation of industry representatives in all meetings of the Study Direction Commission, which ensures that the discussed issues are adjusted to the needs of the industry, as well as receiving new proposals from industry representatives. In addition to the above, the involvement of industry teaching staff in the implementation of specific study courses is carried out, which allows not only the actualization of specific topics, but also allows maintaining a sufficiently intensive dialogue with specific companies of the industry about the needs of the industry. The director of the study program is a member of the board of LIKTA, the industry's largest association, which allows us to obtain the needs of the industry and influence the development of the industry at the same time, thus contributing to the achievement of the goals of the study program and the field of study

A specific and distinctive feature of the study program is the course blocks in the field of artificial intelligence and autonomy, which make the program highly relevant to the current trends. Comparatively, in the first phase of accreditation (starting in 2012), the program has evolved from a future-oriented to a presently topical study program, which is much more conducive for attracting students (the average competition for the state budget funded seats is approximately 1.7 students per seat). This attests that the program is in line with both public perception of technological developments and industry trends.

One of the achievements is the successful establishment of companies in the field of artificial intelligence and robotics by graduates of the study program - Ltd Asya and Ltd RoboticSolutions, which have worked in the technology market and technology development for several years.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

According to the aims and tasks of the study program, study courses are implemented in different volumes according to the study plan - 1 - 4 or more CP. To implement the study plan, fundamental engineering courses may exceed 4CP, thus emphasizing the importance of specific fields in engineering. For example, mathematics and physics are allocated a relatively higher volume than the courses specializing in a particular field. The specialized courses in the program area amount to 3 or 4CP, which allows both developing the theoretical knowledge and devoting sufficient time to the acquisition of practical skills and to independent work. It should be stressed that most courses of more than 2CP also include practical work or group work.

This approach to structuring the program and focusing on specific areas is in line with the existing good practice in Latvia and beyond.

In addition to the lectures or practical classes, a certain amount of CP is provided for group work or independent work (at home or in the laboratory). It should be stressed that the program is particularly proud of its access to the Robotic Prototyping Laboratory, which provides students with experience in prototyping and application of appropriate methods for design and development of robotic systems already in the first semester. These are the courses DSP802 “Robot Control System Development Project” and DSP105 “Introduction to Study Field”. These courses greatly enhance the curriculum by allowing students to gain experience in all phases of robotic system development within a single project, thus preparing them for the job market.

Group work is supported by a number of courses, the aforementioned DSP802 "Robot Control System Development Project", SDD701 "Innovative Product Development and Entrepreneurship", DSP724 "Foundations of Computer and Robotic Systems Design", as well as other courses to a lesser extent. Student collaboration within a group, as well as performance of specific roles during the simulation of a design project, provides insights into the implementation of industry-specific design processes, and helps gain experience in the development and implementation of an integrated communication system. For example, DSP724 requires the selection of a project management and communication platform - Jira, MS Teams, or another platform of choice - and the systematic documentation of the project progress (including a project notebook), thus bringing the course closer to the realization of a practical project.

In order to facilitate student collaboration and the development of independent problem-solving skills, students are offered a wide range of equipment and infrastructure - laboratories, virtual solutions (virtual computers, HPC, etc.), unified RTU software services (MS Teams, Office 365, Solidworks, etc.), prototyping equipment (CNC, laser cutting equipment, SMD assembly equipment, LabView Measurement Equipment, IOT laboratory, meeting rooms and equipment, as well as other specific equipment. In addition to the above mentioned, the course DSP802 "Robot Control System Development Project" offers student groups a budget for the purchase or rental of equipment, parts and facilities, which allows projects to be developed independently of existing equipment, if necessary. The budget is mainly provided from the financing of the implementation of industrial projects.

To encourage student involvement in further studies and to provide research experience, the study program also offers part-time work in specific practical research projects. At the time of writing the report, students are involved in the following projects: the H2020 ECSEL CHARM project, iDārzs, several innovation voucher projects by the Investment and Development Agency of Latvia (LIAA) and, during the accreditation period, new product development projects of LIAA.

In the framework of such courses as DSP716 "Robot Systems Modeling Basics", RTR220 "Basics of Signal Theory", MTM208 "Robot Kinematics", as well as in the practical parts of courses of general education, modelling software systems Matlab with Simulink, ABB Robot Studio, Solidworks, Mathcad, Mathematica, etc. are used, which also allows developing virtual system design skills according to the requirements of contemporary industry.

In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific undergraduate paper research, the choice of a particular major, as well as in group work, which to a large extent also allows manifestation of organizational skills, leadership qualities and other transdisciplinary skills. In several courses, such as DSP332 “Fundamentals of Artificial Intelligence” or DIM707 “Discrete Mathematics”, the course material is supplemented with e-content, which allows students to choose the form of learning according to their perceptual characteristics. These materials can be combined with traditional lecture-oriented content to complement their skills and knowledge.

In order to enable effective use of the study materials for practical and independent work, RTU uses the ORTUS e-learning environment, additional communication opportunities provided by this system as well. Self-testing (automated test options) and interactivity are used in several courses as part of the study process. For example, several lecturers - A.Ņikitenko, A.Anohina-Naumeca, K. Bločko, etc. - widely use such tool as Mentimeter (Interactive presentation software - Mentimeter), which allows getting feedback on the dynamics of learning the material and student experience.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

In the reporting period, approximately 50 young professionals have graduated from the study program, having fulfilled the program requirements and developed a graduation paper.

The thematic groups are divided according to historical experience and industry best practice, which envisions distinguishing between automation solutions, which are more oriented towards manufacturing processes, and other robot control problems, such as intelligent control, or multi-robot systems in general. It also separates generic or combined AI solutions from machine learning, which is in line with current AI trends. Given that the thematic groups may also cover applications of AI in software solutions not directly related to robotic systems, the topics of these groups are also categorized for analysis.

The themes of the graduation papers can therefore be grouped as follows:

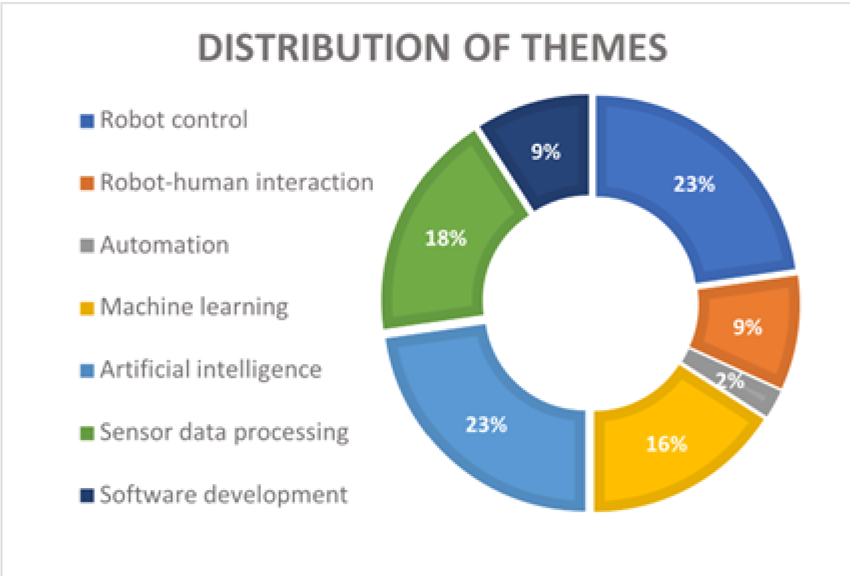
- Robot control - controlling the hardware and movements of robots to perform different tasks.
- Robot-human interaction - themes are largely related to communication issues, which are essential in modern robotics;
- Automation - themes in this group are related to solving problems of automation of various manufacturing processes;
- Machine learning - themes in this group focus on applications of deep machine learning technology in robotics or AI in general;
- Artificial intelligence - themes in this group relate to artificial intelligence techniques that

may not be directly related to robotic systems or machine learning.

- Sensor data processing - themes focusing on sensor data processing issues such as filtering, fusion or the use of new types of sensors, as well as methods that integrate with other methods or techniques.
- Software development - a range of themes that focus on software engineering issues and may not be directly related to robotic systems.

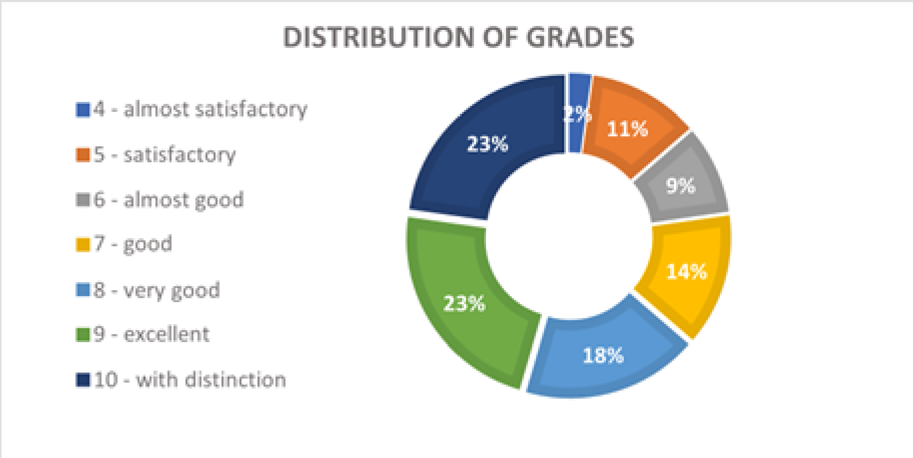
The relative distribution of themes according to this classification is shown below. As it can be seen, the distribution of themes is in line with the fields of specialization of the study program, focusing on those topics that are relevant to robot control and artificial intelligence.

It should be highlighted that about 16% of the topics are related to advanced areas of artificial intelligence - machine learning, and 9% are related to robot-human collaboration in everyday applications such as medicine.



Looking at 50 key terms in the topic titles (see below), the topic titles are also relevant to the specialization of the study program, emphasizing mobile robotic systems, deep machine learning, sensor analysis and other themes mentioned above.

The results of analysis of the graduation paper grades are presented in the following figure:



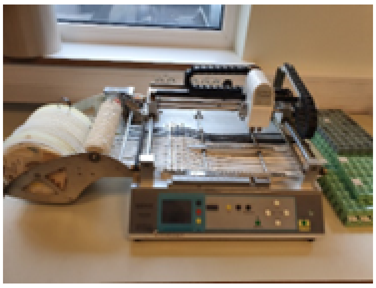
It can be seen that more than a half of the graduates have obtained an assessment “very good” and above. The evaluation is carried out by a committee, which traditionally includes not only the instructors implementing the program, but also representatives of other RTU departments, as well as the Latvian University of Agriculture, which improves the quality of the committee’s work. This composition of the committee is part of the continuous quality assurance approach to ensure the most objective evaluation and a multifaceted view of the results achieved in the graduation papers. Thus, graduation paper grades attest a relatively high quality of the graduation papers.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

During program implementation period, significant investments have been made to supplement the material and technical resource base for the implementation of the study program both for the provision of studies and for scientific and applied research. All available resources can be divided into centralized resources, such as subscriptions maintained by the RTU Scientific Library and electronic repositories, and study program-specific resources that complement the centralized resources. The centralized resources are described in detail in the relevant sections of the Study Field Resources. Specific equipment is described in detail below:

Image	Description	Use

	SMD assembly line. The line is designed for the production of small electronic circuits. The line includes an assembly robot, a solder paste application machine and a soldering thermal chamber. As part of the study program, it is used for the production of sensors for teaching robot systems, as well as for the production or prototyping within students' graduation papers.	Studies Research
	3D printers. In addition to the RTU Design Factory, the Robotic Prototyping Lab of the Faculty of Computer Science and Information Technology offers access to 3D printers for prototyping. The printers, together with appropriate software available to all RTU students (Solidworks, CURA, etc.), are used in the courses "Introduction to Study Field" and "Robot Control System Development Project".	Studies Research
	Robot Baxter. Provides two synchronized manipulators working together, augmented with different types of sensors and tools (pneumatic grippers, electric grippers, etc.). The robot is used for various demonstration projects and for training students in the basics of industrial robot control. The robot was part of the research project RobotCom++.	Studies Research

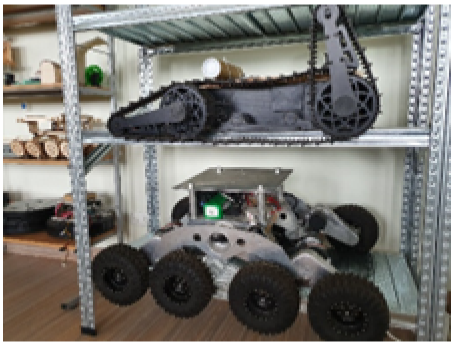
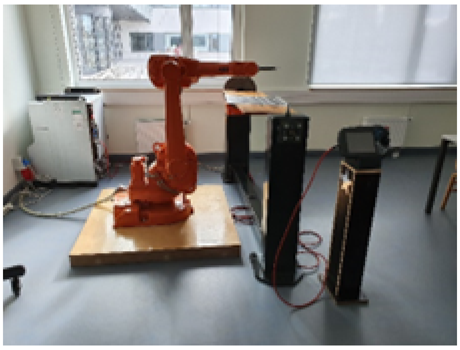
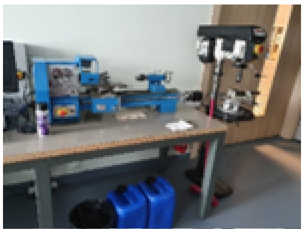
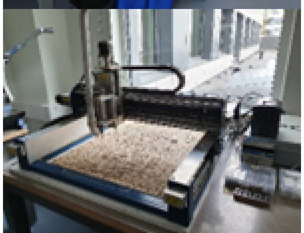
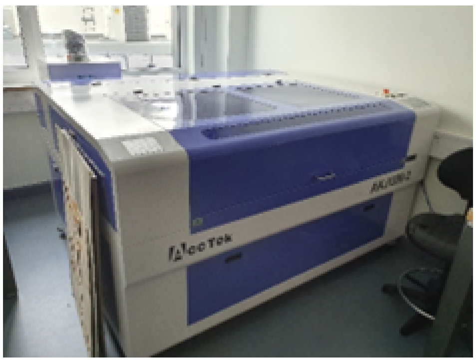
	Robot Pepper. Used for student projects and demonstration purposes. Actively used within the course “Robot Control System Development Project”, where students develop Robot-Human Interface projects, thus learning more complex development environments and corresponding applications.	Studies Research
 	A prototyping room that serves as a testing ground for various projects. The images show materials available to students and researchers, as well as equipment and robots actively used in industrial developments.	Studies Research
	Prototyping platforms. The platforms are mainly used for students' graduation papers, as well as for the course “Robot Control System Development Project” helping them learn the control features of different platforms.	Studies Research

	ABB IRB 1200. An industrial robot used mainly in the context of studies to provide hands-on experience within industrial robot control courses. The robot has also been used in the RoboCom++ project as part of a demonstration production line.	Studies Research
	ABB IRB 1600 An industrial robot used mainly in the context of studies to provide hands-on experience in industrial robot control courses. The robot is actively used for various student designs and demonstrations. The robot is part of a robot programming teaching laboratory which is used to provide students with skills and knowledge in robot modelling and programming.	Studies
  	CNC equipment CNC equipment is used for student projects and graduation papers. Given that the use of the equipment can involve specific knowledge and skills, HAAS CNC equipment is only used with the assistance of an experienced engineer, and the simplest equipment with appropriate instruction.	Studies Research
	Laser cutting equipment The equipment is a relatively recent acquisition (shortly before the report was written) and has not yet been integrated into the study process, but it is being used for development of various prototype equipment. The equipment is only used by experienced engineers who have been appropriately trained.	Research

	Measuring equipment and reference materials. For the purpose of the study program, large stock of measuring equipment (oscilloscopes, digital signal analyzers, radio signal analyzers, multimeters, and other specific measuring equipment), hand-held instruments are available. This equipment is complemented by RPi, ESP32, Arduino and other microcomputers available for study and development purposes.	Studies Research
	Robotics kits Designed for development purposes and for learning the basics of electronics and programming mobile robots. The kits are complemented by electronic learning material that can also be used for distance learning.	Studies

As mentioned above, specific equipment is also used for study purposes and is available centrally as well as at other faculties. The Faculty of Electrical and Environmental Engineering is the most important contributor, providing the necessary measuring equipment and visual learning aids for the study process, in particular Siemens industrial automation laboratory, motor control equipment, etc. Thus, it can be argued that the equipment and resources available for studies are relatively abundant and sufficient also for students’ activities outside studies.

A detailed description of the infrastructure and material-technical base, as well as methodological and informational provision, is given in Chapter 3 of Part II of the course description, "Resources and provision of the study course", where subsection 2.3.2 is devoted to the description of the infrastructure and material-technical provision, while 2.3.3 is given a detailed reflection of methodological and information provision (including the range of options offered by the RTU scientific library). Subchapter 2.3.4 is devoted to the description of the information and communication technology solutions used.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between

the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

According to the RTU regulations, study programs are financed mainly from state budget funds and tuition fees, which are used for staff remuneration, infrastructure development and other essential aspects. Formally, RTU revenues and expenditures are managed according to the principles approved by the Senate, or by the Vice-Rector of Finance with the authority granted to him.

Revenue is allocated to the organizational unit in accordance with the needs and regulations of the program for the execution of specific work for which it is responsible, i.e., implementation of specific courses, provision of tutorials based on the planned volume of work and/or indicators reported in previous periods (e.g., scientific support). RTU provides each Head of Organizational Unit with remote access to operational financial information on the Organizational Unit's budget, including the planned workload and the corresponding funding to be allocated in future periods for the implementation of study programs and study courses.

Heads of Organizational Units are responsible for the use of the funds at the Organizational Unit's disposal in accordance with the plans developed at the beginning of each budget year through access to the RTU financial management information system.

Currently, state budget funded seats at the study program "Intelligent Robotic Systems" are fully filled and there is a stable competition for admission, which attests the quality and financial self-sufficiency of the study program. The main sources of funding for the program by year are listed in the table below:

Academic year	State subsidy, EUR	Local student tuition fees, EUR	Total study program funding, EUR	Funding of one state budget funded seat, EUR
2013/2014	71909.00	1380.00	73289.00	3866.00
2014/2015	77087.24		77087.24	3866.02
2015/2016	82770.46		82770.46	3866.02
2016/2017	92872.51		92872.51	3866.02
2017/2018	96369.78	180.00	96549.78	4040.66
2018/2019	100408.22	480.00	100888.22	4229.68
2019/2020	114089.54	5520.00	119609.54	4405.04
2020/2021	114491.23	6960.00	121451.23	4462.81

Detailed information on the distribution of funding between cost items is provided in the appendix to the self-assessment report "Distribution of funding between cost items". Information on the minimum required number of students in the program is given in the appendix to the self-evaluation report "On minimum number of students in the study programs".

Given the active involvement of the staff, the participation in various externally funded research and development projects, the involvement of teachers in several programs at the same time, and the judicious and far-sighted use of study funds, it can be said that overall funding is sufficient and allows for further development.

The available funding is mainly used to pay the work of teaching staff, as well as to maintain and improve the teaching infrastructure. The implementing structural unit – the Department of Artificial Intelligence and Systems Engineering, in the person of its head and the director of the study program, is responsible for specific financing tasks. Funding decisions are made at the department, institute or faculty level, depending on the specific event. Significant efforts are devoted to enriching the skills and abilities of teaching staff, therefore part of the funding is devoted to paying for various courses, seminars, business trips, as well as academic vacations. Also, an investment is systematically planned for the addition of ICT equipment, specifically for the provision of virtualizable computing resources, which are necessary for the operation of computer classes and the implementation of research processes. The implementation of the mentioned activities in accordance with other significant investments in the infrastructure and the improvement of the curriculum provides a synergistic effect for the development of the study program as a whole.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff implementing the study program fully correspond to the specifics of the study program and the requirements of the regulatory enactments. The interdisciplinary nature of the study program requires attraction of highly qualified specialists, specializing in specific thematic areas of study courses, providing their experience in relevant business areas or offering a combination thereof, thus ensuring excellence of the academic performance of the program. Below is information about the leading members of academic staff involved in the implementation of the program.

Dr.sc.ing. Agris Ņikitenko is a Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). He is the author of more than 35 scientific publications, several textbooks and patents. He has co-founded several companies, including RoboticSolutions Ltd. and RobotNest Ltd., and actively participates in the strengthening and development of the Latvian ICT ecosystem. He has been the Head of the study program “Intelligent Robotic Systems” since its inception and is the initiator of the program. Currently, he is a member of the Latvian Information and Communications Technology Association (LIKTA) Board, LEO Competence Centre Board, RTU Robotics Club Board, and is active in various expert discussions and platforms. He is an active expert at the Latvian Council of Science (LCS) and part-time Associate Professor at the Norwegian University of Science and Technology (NTNU) since 2021.

Dr.habil.sc.ing. Jānis Grundspeņķis is a Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). He has actually established the FCSIT School of Artificial Intelligence and has ensured defense of more than 13 PhD Theses in this field. He is the author of at least 110 publications, sole author of many textbooks and co-author of other academic publications. He is an active principal investigator in scientific research projects, as well as the leader and implementer of collaborative projects. He is the Head of the Doctoral Council P-07, as well as an expert of the LCS and chair of the Expert Committee in Computer Science. He is the architect and the head of the faculty's most sought-after study program “Computer Systems” since its launch until 2019. Under his leadership, a quality management system for the study environment at FCSIT and a work culture among the faculty team have been established, which jointly ensure effective management and implementation of the study programs.

Dr.habil.sc.ing. Leonīds Ribickis is an Academician of the Latvian Academy of Sciences, Rector and Professor at RTU. He is a member of several Latvian and international organizations, including the Senate of the LAS (until 2020), a member of the Board of the Association of Latvian Universities (until 2019), a member of the Network of Rectors and Deans of Nordic Technical Universities, a member of the IEEE Worldwide Institute of Electrical and Electronics Engineers and the Head of the Latvian Section, a co-author of at least 30 Latvian and international patents (about 40 USSR patents), co-author of more than 600 scientific publications, including 21 monographs. Under the scientific supervision of Leonīds Ribickis, 13 PhD Theses have been publicly presented. He is among the leading experts in electrical engineering, energy and power electronics at RTU, who shares his expertise with students and faculty in at least 10 study courses.

Dr.sc.ing. Alla Anohina-Naumeca is an Associate Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). In 2015, she received a Doctor of Education degree from the University of Latvia. She is one of the most recognized faculty members by students, contributing to the goals of academic excellence at FCSIT also in the position of the Deputy Dean for Academic Affairs since 2018. She is an active expert at the LAS and part-time professor at the Norwegian University of Science and Technology (NTNU) since 2021. She is an active contributor to the academic integrity policy at FCSIT and RTU. In 2020 and 2021, she honed her academic skills at the University at Buffalo (USA) in order to improve the study process and move towards increasingly high-quality studies. She is an active participant in scientific research projects as well as a creator of Massive Open Online Courses (MOOCs) at RTU.

Dr.sc.ing. Egons Lavendelis is an Associate Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). Author of more than 35 scientific publications and the leader or executor of several scientific research projects. Since 2019, he is the Head of the RTU Institute of Applied Computer Systems and the Head of the study program “Computer Systems”, ensuring excellence of the study program and the Institute. He is the responsible instructor at several courses, including “Multi-Agent Systems”, which is one of the best appreciated courses in the study program. Since 2017, he is the Head of the RTU Sports Centre and has been responsible for the reform of the Sports Centre at RTU. He is actively involved in strengthening academic excellence and is the author of many initiatives, including the activities aimed at strengthening of the quality of study programs and promotion of the principles of academic integrity.

Dr.oec., Elīna Gaile-Sarkane is a Professor of the Faculty of Engineering Economics and Management (FEEM), Riga Technical University (RTU). E. Gaile-Sarkane has authored more than 140 scientific publications since 2000 and has more than 20 years of research experience. Many papers have been published in internationally recognized journals or conference proceedings indexed in international databases (e.g., Thomson and Reuter, Scopus, EBSCO, etc.). Co-author of two patents, both developed within the framework of the study program “Innovation and

Entrepreneurship". Prof. Elīna Gaile-Sarkane is a member of RTU Doctoral Board P-09, expert of LCS, expert of the Czech Grant Agency, member of many international organizations, member of the Joint Professorial Council of Riga School of International Economics and Business Administration, School of Banking and Ventspils University College in the field of Management and Economics. Prof. Gaile-Sarkane's research interests are highly interdisciplinary, covering management, innovation management, technology transfer and various aspects of entrepreneurship.

It should be emphasized that in addition to the senior academic staff, other academically excellent and active colleagues contribute to the study program, ensuring its high quality, development and day-to-day achievement of the program's objectives. Detailed curriculum vitae of academic staff can be found in the relevant annexes.

During the accreditation period, active work has been carried out on professional development and mobility activities, which have involved attracting guest lecturers from Latvia and abroad. A summary of such guest lectures is given in the following table:

The following guest lecturers worked at the program within **SAM8.2.2. project:**

Stojmenovic Milos (Serbia, Canada), As part of the visit, a new study course DSP793 "Introduction to Deep Machine Learning" was created, which is now available at the study program "Intelligent Robotic Systems" as well as at other study programs.	01.02.2020.	31.07.2020.
Czekalski Piotr Boleslaw (Poland), As part of the visit, a new study course DSP791 "Introduction to Internet of Things Technologies and Applications" was created, which is now available at the study program "Intelligent Robotic Systems" as well as at other study programs.	21.02.2020.	20.08.2020.

In cooperation with **IEEE Latvia Section**, the following guest lectures were held for students and staff of the faculty:

- 06.06.2016. Embedded Systems as Foundations of Cyber-Physical Systems, Bernadetta Kwintiana Ane, IEEE Distinguished Visitors Program;
- 25.10.2017. Big Data Science as a Service, Sherif Sakr, IEEE Distinguished Visitors Program;
- 26.11.2018. 2020: Toward Practical Quantum Computing, Marcello Caleffi, IEEE Distinguished Visitors Program.

Guest lectures delivered by the companies:

- 03.12.2019. How to Create Effective Solutions for Business: Approach and Technologies, guest lecture by "Consolware";
- 12.02.2019. Computer Vision, Robots, Cobots – who will solve difficult tasks in the near future? guest lecture by "Peruza".

Faculty organized seminars, providing the forum for discussion of topical issues related to the implementation of the study process and experience exchange:

- 20.02.2019. Academic Integrity and Work with the Foreign Students;
- 18.12.2020. Organization of Exam in the Remote Mode;
- 12.02.2021. Implementing Studies in the Remote Mode;
- 12.03.2021. Student of the Digital Age (Zanda Rubene, UL professor);
- 28.01.2022. Academic Integrity at RTU and FCSIT;

- 25.02.2022. Formative assessment: with and without technology (Anžela Jurāne-Brēmane, ViA researcher).

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The total number of academic staff as well as the distribution of qualifications did not change significantly during the reporting period, with 13 professors, 6 associate professors and 1 assistant professor being involved in program implementation. All involved academic staff holding a PhD degree have Riga Technical University as their main employer. Changes in the number of academic staff within specific courses are related to the continuous quality management within the study program.

In the context of quality management of a study program, the replacement of an academic staff member may be attributed to several factors:

- Replacing a study course with another, thus excluding a particular member of the academic staff from working with students;
- A change in the curriculum of a study course requiring a change in the composition of the academic staff;
- Quality assurance measures for a study course requiring the replacement of a specific member of the academic staff by another member in the same field;
- Voluntary changes in the working relationship of an academic staff member, which may involve a change in the volume or structure of the workload within a specific study program.

Quality assurance of program implementation is a key responsibility of the head of the study program, which requires that reports or incidents compromising the quality of a particular program be investigated and responded to through negotiation, deeper analysis or, in cases of extreme necessity, replacement of a member of the academic staff with another member in the relevant field.

The decision to change the academic staff in this case may be made at the level of the management of the organizational unit responsible for the study course, as a reaction to poor quality work, or as a consequence of the decision of the Study Field Committee to replace a member of the academic staff. Given the relatively high culture of internal communication between RTU and FCSIT, the Study Field Committee has not faced any issues of this nature during the reporting period.

Changes at the level of organizational unit have taken place in the following courses:

- **SDD701 “Innovative Product Development and Entrepreneurship”**. In fact, the lecturer who implemented the course was replaced by an expert in the field, Andris Ozols. The replacement was made in response to repeated complaints from the students of several study programs about the teaching methodology and communication with students. Since the replacement of the lecturer, very positive feedback has been received.
- **DDI701 “Industrial Robot Control Systems”**. As a reaction to several complaints about the pedagogical methods used by the lecturer, the lecturer was changed to Dmitrijs Bliznuks and teaching assistant Matīss Eriņš, who have improved the content, methodology and technical support for the implementation of the course as a result of joint work. Here again, the feedback has been very positive.

- **EEM730 “Special Electrical Machinery for Robotic Systems”**. The replacement of the lecturer with Andrejs Podgornovs was made in response to student feedback on the course content and teaching methods, which was not in line with the objectives and outcomes of the study program. The replacement of the lecturer has led to a significant improvement in student feedback on the implementation of the course.
- **DIP107 “Algorithmization and Programming of Solutions”**. The course lecturer was replaced by Marina Uhanova in order to improve the quality of studies and student achievement in line with the program objectives. The new skills and competences acquired by Marina Uhanova within the "Buffalo" program, which provides faculty training at the University at Buffalo, USA, were used. The changes in the course have resulted in a significant change in the pedagogical approach to the organization of practical work, which has also improved student feedback.
- **DSP723 “Logical Foundations of Intelligent Robots”**. The lecturer was changed due to the lecturer’s voluntary change of workload and “transfer” of the course to younger colleagues. No significant changes in the delivery methodology or student feedback could be observed.
- **DSP332 “Fundamentals of Artificial Intelligence”**. The change of a lecturer was made due to a voluntary change in the lecturer’s workload and the “transfer” of the course to younger colleagues. No significant changes in the delivery methodology or student feedback could be observed.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the

number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

In line with the academic excellence pillar of the RTU Strategy, several channels and formats of collaboration are available to academic staff. These include:

- **E-learning environment**: provides extensive functionality for collaboration between academic staff and students within specific courses. The most important functions are content management, management of assessment methodologies and grades, management of communication with students (in the form of questions, reports and assignments), management of tests and their results, among others. The e-learning environment also enables several academic staff to work simultaneously on the content of a specific course in the e-learning environment, thus enabling efficient use of electronic resources and providing the necessary support to students;
- **E-conferencing platforms**: (appropriately licensed ZOOM and MS Teams) providing technical support for daily collaboration - discussions, working meetings and simple exchanges of views that enable faculty to work together on a daily basis;
- **Annual academic conferences and seminars**, which allow discussing the latest trends in education methodology, its implementation, sharing experience among educators from different fields within the RTU team. Each year, the academic conference and various types of seminars allow updating important aspects of academic work, as well as learning from each other. Academic seminars are devoted to specific aspects of academic work, including the use of various interactivity tools, such as Interactive presentation software - Mentimeter, for the organization of the study process, discussion of different types of experience in the development of graduation papers, as well as other issues. Academic seminars are organized as needed.
- **The Study Field Committee**, which provides an opportunity to discuss the curriculum, methods and results of studies, both among academic staff and industry representatives. Depending on the issues at stake, other faculties are also involved in the discussions and can make an important contribution to promotion of academic excellence. The sectoral committees are the most important platform for discussions on balancing and structuring the curriculum of different courses, allowing academic staff from different fields to discuss and decide on the content and format of studies.
- **Councils of Organizational Unit and Institutes** provide for a more specialized discussion between representatives of a specific field or study program on the aspects of implementation of specific study courses, including curriculum, assessment methodology, learning outcomes and other issues related to the implementation of studies;

In order to promote cooperation among academic staff, several decision-making procedures are implemented. They include open discussion of issues in appropriate platforms, as well as participation in academic conferences or seminars as part of the set of criteria for assessing the quality of academic staff in accordance with the RTU methodology.

RTU Study Department, within the scope of its competence, promotes the responsibility of different specialization units for the study curriculum of the field they represent, i.e., a particular specialization unit, regardless of its affiliation to a particular faculty, provides study courses of its specialization within the study programs (regardless of the profile), in which the relevant courses are included. This promotes cooperation between fields in jointly implemented study programs and specialization within the respective fields at the same time.

Given the openness of the study program and the faculty as a whole, and the collaborative internal communication, it can be states that the collaboration between the academic staff of different specializations or departments is very good or excellent.

At the time of submission of the self-assessment report, the program has a total of 66 students and 30 educators (for different courses, including those taught jointly with students from other programs). Therefore, student/educator ratio is 30 / 66 = 0.45.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DBR0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DBR0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DBR0(43526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DBR0(43526)_AIP_atzinums250stud_Intelekt_robot_sist.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DBR0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DBR0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DBR0(43526)_CompliancewiththeStateEducationStandard_AkadBak_ENG.pdf	P06_3.2.1_DBR0(43526)_AtbilstibaValstsStandartam_AkadBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DBR0(43526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DBR0(43526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DBR0(43526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DBR0(43526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DBR0(43526)_StudyCoursesdescr_ENG.zip	P10_DBR0(43526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Computer Systems (43526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Systems*
Education classification code	*43526*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Egons*
Surname of the study programme director	*Lavendelis*
E-mail of the study programme director	*Egons.Lavendelis@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089548*
Goal of the study programme	*The aim of the study programme is to prepare professionals for starting independent work in the field of informatics with knowledge in software engineering, research and solving computer engineering problems, computer systems development, systems analysis and modelling, fundamentals of database technologies and artificial intelligence, as well as with ability to demonstrate systems thinking and/or systems approach and participate in software development project, fulfilling different roles, who demonstrate professional ethics and knowledge/skills complying with IT industry standards. Prepare students for the continuation of studies both at professional (fulfilling additional requirements) and academic Master studies level.*
Tasks of the study programme	*Study programme tasks are the following:* *- To provide knowledge in mathematics and physics in accordance with the highest technical engineering education requirements.* *- To provide basic knowledge in computer science, focusing on software engineering, computer systems development, database technologies, systems analysis and fundamentals of artificial intelligence.* *- To develop students' practical abilities to work with various software.* *- To practice students in programming and professional use of computers.* *- To develop students' ability to independently acquire, evaluate and use new software products.* *- To improve the students' professional skills in foreign languages.* *- To introduce students with the professional ethics and IT industry standards.* *- To improve students' oral and written communication skills as well as to develop students' skills in team work.* *- To provide the initial scientific research skills, developing Bachelor Thesis.*

Results of the study programme	*Graduate of the study program: - has acquired knowledge in computer science in general and its formal basis; - is able to choose the appropriate algorithms (including artificial intelligence based), methods, software products and tools for solving problems; - is able to use software development environments and tools as well as to develop - software according to the best praxis and standards of the IT sector; - is able to study professional literature in Latvian and a foreign language as well as to use professional terminology in the state language; - is able to participate in project development, management, and work in a team, manage, plan and coordinate the working group following the interests of the society as a whole and principles of sustainable development; - is able to plan independently work activities.*
Final examination upon the completion of the study programme	*To receive the academic degree of Bachelor of Engineering Science in Computer Systems, students must accomplish the syllabus and work out and defend their Bachelor Thesis. The volume of the Bachelor Thesis is 10 credit points. Bachelor Thesis must be publicly defended, and a reviewer is appointed for its evaluation. The guidelines for contents and evaluation criteria are described in "Requirements for the final thesis of the academic bachelor's study program at the Institute of Applied Computer Systems".*

Study programme forms

Full time studies - 3 years - latvian

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*120*
Admission requirements (in English)	*General or vocational secondary education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Computer Systems*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 3 years - english

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*english*
Amount (CP)	*120*

Admission requirements (in English)	*General or vocational secondary education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Computer Systems*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

As part of the evaluation procedure of the study field, the educational classification code of the study program was changed to 43526 – other engineering sciences and the degree to be awarded to “Bachelor Degree of Engineering Science in Computer Systems”. This change was made in view of the fact that the study program “Computer Systems” basically covers computer systems development technologies supplemented by basic engineering courses. A study of various sources, including university curricula in the European Union and other countries, reveals that today information and communication technologies is a branch of engineering sciences that aims to develop and research methods, tools, approaches, technologies and technical solutions to solve practical problems in order to improve people’s living conditions. This distinguishes information and communication technology as an engineering discipline that uses scientific knowledge to solve practical and technical problems in order to create objects that do not exist in nature, from natural science, which studies the patterns and phenomena that exist in nature.

In accordance with the Cabinet Regulation No. 240 of 13 May 2014 “Regulations on the State Standard of Academic Education”, the volume of program has been changed from the historical 121 CP in 2013 to 120 CP in 2022.

Given the dynamic nature of IT, the content of the study program and curriculum of each study course are regularly reviewed. At the level of the study program, a regular assessment of the relevance of the existing study course to the current situation in the industry and science is made. If an existing study course is found to be outdated or for any other reason does not fulfil its intended purpose in achieving the objectives of the study program, it is replaced by a new study course. At the level of study course, each responsible instructor reviews the content of their course to ensure that it is up-to-date with the latest technologies and trends in the field. When significant changes are made to a study course, they are first reviewed by the Institute of Applied Computer Systems Council so that all organizational units implementing the study program are aware of the changes and so that consistency between study courses within the program is ensured.

As of 2019, the requirements towards graduation papers have been unified across the Faculty and the Institute. In 2020, unified requirements for graduation papers have been developed for all program specialisations and in 2021, a unified Bachelor Theses Defence Committee with the unified requirements has been introduced. In 2021, the process of developing Bachelor Theses has been unified across the Faculty of Computer Science and Information Technology.

Based on Section 6 of RTU Internal Code of Student Conduct, RTU Code of Academic Integrity and RTU Study Department’s guidelines “Breach of Academic Integrity and Breach Consideration Procedures”, since 2018 an enhanced plagiarism control has been introduced for graduation papers written in English and since 2021 for all graduation papers. In 2019, a procedure for reviewing academic integrity violations was adopted (FCSIT Council Decision No. 12000-1.1/9 of 14 June 2019 “On the Procedure for Reviewing Cases of Plagiarism in Graduation Papers of Students at the

Faculty of Computer Science and Information Technology of RTU"), ensuring objective review of the violations. Since 2021, electronic plagiarism control has also been introduced for all student papers. An electronic system developed at the Institute of Applied Computer Systems is used for this purpose.

As the program is implemented in full-time on-site mode, in order to ensure that at least 50% of the workload is completed in contact hours, the semester planning has been changed from a 4-week examination period to a single 20-week semester plan for mastering the study course curriculum and examinations in the autumn and spring semesters.

The other main parameters of the program – languages of implementation (Latvian, English), type of implementation (full-time) and admission requirements – remained unchanged during the evaluation period.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The volume of the study program is 120 CP and duration of studies is 3 years, which is in line with Cabinet Regulation No. 240 of 13 May 2014 "Regulations on the State Standard of Academic Education". The duration and volume of the program allows developing the skills necessary for young specialists and allows young IT specialists to start working in the profession sooner, which is particularly important given the demand for IT specialists in the Latvian IT sector.

The study program corresponds most closely to the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", as the curriculum of the study program focuses on software engineering and includes knowledge and skills relevant to information technology, computer science and, to some extent, computer engineering and computer control.

The title of the study program "Computer Systems" covers all areas related to software engineering. Computer systems development requires knowledge in computer science, information technology, computer engineering and computer control. The program focuses on computer systems development, systems analysis, systems modelling and design, algorithmisation, including the development and use of algorithms necessary for artificial intelligence systems.

The classification code 43526 of the study program Computer Systems – engineering sciences and technologies (other engineering sciences) has been selected because the aim and content of the program is related to the development of computer systems, which is the creation of engineering solutions to solve specific problems important for the society, which by their nature correspond to engineering sciences. After the accreditation the degree to be awarded will be Bachelor of Engineering Science in Computer System.

The aim of the study programme is achieved by performing all the study programme's tasks. The tasks of the study program envisage the provision of knowledge, the development of professional and communication skills and abilities necessary to achieve the goal in study courses, as well as conducting independent research within the framework of a bachelor's thesis. The study results are developed according to the tasks and verified in study courses theoretically and practically, and during the defense of the bachelor's thesis.

The study program is designed to educate and train IT professionals with the knowledge of software engineering, computer systems development, engineering problem research and solving, systems analysis, modelling and design, basic database technologies and artificial intelligence fundamentals, and with the ability to think systemically and participate in software development projects, fulfilling a variety of roles and adhering to IT industry standards and professional ethics.

Admission to the program is open to secondary school graduates on a competitive basis. The competition is organised on the basis of the “Rules for Admission to Academic and Professional Undergraduate Programmes” approved by the RTU Senate, with an increased value given to STEM subjects from school programs, as well as to foreign language, which is the basis for successful mastering of the IT field. The admission requirements have not changed over time and are recognised as qualitative criteria for the selection of students to be able to achieve the set objectives of the study program and, upon successful completion of the study program, to graduate with the defined learning outcomes.

The duration of the study programme (3 years) is sufficient so that applicants with secondary education can acquire the theoretical and practical knowledge, skills and abilities expected as the results of the study programme to the full extent in accordance with the legislative requirements of the Republic of Latvia.

The study programme is implemented in two languages – Latvian and English. The use of the English language allows increasing the number of students thanks to foreign applicants, attracting participants of international students exchange programs and improving the indicators of the implementation of the study programme.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 stipulates that ICT advances and their widespread availability are a catalyst for change in the economy, public administration and society as a whole. The knowledge society, through the targeted application of ICT solutions, transforms existing and creates new processes, business models, habits and culture in all spheres of the economy and life. Digital transformation is the key to productivity, economic growth, individual and societal well-being. At the same time, the number of ICT professionals in Latvia, according to the European Commission’s Digital Economy and Society Index, was only 2.2% of the workforce in 2018, well below the European Union (EU) average of 3.7%. The study “Future Goals, Current Directions. Latvia 2022” conducted by the think tank Certus in 2017, revealed that IT sector in Latvia needs up to 3,000 new graduates per year.

According to the Latvian statistics portal, the share of companies employing ICT/IT specialists has increased by 5% in the last 7 years and has reached 73% in 2020. According to the study “Competitiveness of Regions. Latvia Competitiveness Report 2019” conducted by Certus in 2019, the salaries of ICT professionals in leading EU countries are about 30% above the national average, in Latvia the gap is 80%.

Graduates of the study program Computer Systems can start professional career in ICT companies by performing a variety of roles. The study program provides knowledge and skills for junior positions as programmers, testers, system analysts, data analysts and others. According to the Ministry of Education and Science data on 2017 and 2018 graduates, on average of 88% of graduates are employed one year after graduation, 90% of them in higher qualification professions according to the Ministry's classification. The average income one year after graduation is above EUR 15 000 per year and two years after graduation above EUR 21 000 per year. The number of unemployed one to two years after graduation is below 2%. The share of graduate emigration is also low, around 1.2%. When assessing the employment of graduates by NACE codes, it can be concluded that more than 50% work in the Information and Communication Services sector (J), which corresponds most closely to the profile of the study program. In addition, the second largest number of graduates work in the Financial and Insurance sector (K), which is nowadays heavily based on ICT solutions. In addition, many graduates also work in the IT departments of companies in other sectors. It can therefore be concluded that graduates are mostly working in their field of specialisation, working in higher qualification professions already one year after graduation and earning salaries that are well above the national average.

It is very easy for graduates of the study program to get involved in the labour market, which is proven by a large number of available vacancies in Latvia and abroad. In cv.lv (one of the largest job advertisement portals in Latvia), 840 vacancies in the IT field have been published in August of 2022. Positions of different levels in various IT subsectors are offered by Latvian companies and Latvian branches of international companies, such as Accenture (40 vacancies), ATEA (30), EIS group (17). From the offered vacancies, graduates of the study program can apply for various junior specialist vacancies (~180 vacancies), such as junior programmer, junior software developer, junior tester, junior data engineer. There are also a very large number of vacancies available abroad, for example, LinkedIn offers 13,000 junior software developer vacancies in the UK and 12,000 in Germany.

Overall, graduates of the study program Computer Systems have expressed a positive view of the program, across all of the more than 200 questions asked in the 2020 survey. On a scale of 5, the availability of necessary information during studies (4.11), the availability of literature (4.3), the provision of classroom aids (4) and the work of academic staff with the e-learning environment (4.51) were highly rated. Students were also generally satisfied with their choice to study at RTU (3.83), their choice to study in the study program Computer Systems (3.97). Students are satisfied with the theoretical (3.46) and practical (3.05) knowledge they have acquired, the schedule of the lectures and the facilities (3.51) in which the lectures were held. It should be noted that since the survey was carried out, the Faculty has moved to new premises where, at the time of writing of this report, due to the pandemic, students had not yet been able to fully experience the learning process.

The study program Computer Systems is highly rated in prakse.lv surveys – it ranks 6th among all study programs in Latvia, which shows the high evaluation of entrepreneurs.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The academic bachelor study program Computer Systems was implemented in Latvian and English in full-time form during the reporting period.

Despite the demographic situation in Latvia, the academic study program Computer Systems is considered to be a large program with a rapidly growing number of students. The total number of students in the program in academic year 2013/2014 was 484 (88% studied in Latvian, 12% in English), but in academic year 2020/2021 – 981 (68% studied in Latvian, 32% in English). In the last academic year, however, the number of students has slightly decreased to 956 students (61% studied in Latvian, 39% in English), which is a marginal decrease and is probably due to the impact of the COVID-19 pandemic.

At the same time, the number of graduates per year has also increased, from 52 in 2013 (90% studied in Latvian, 10% in English) to 82 in 2020 (85% studied in Latvian, 15% in English). In 2021, the COVID-19 pandemic made it difficult for students in remote working and study mode to complete their graduate papers on time, resulting in fewer students graduating from the program – 68 (87% studied in Latvian, 13% in English). The number of graduates has not increased in proportion to the number of students. One of the reasons for this is the significant increase in the proportion of international and mobility students (from 60 international and 26 mobility students in 2013 to 377 international and 135 mobility students in 2021). Mobility students do not graduate at all, while international students have a lower graduation rate per student due to weaker prior training. The increase in the number of mobility students is due to both the reputation of the program among international students and the cooperation with several foreign educational institutions that recommend their students to spend part of their study time at RTU. Examples of such institutions are EPITA, School of Engineering and Computer Science, and IPSA, Institute of Polytechnic Science and Aeronautics in France.

The number of international students has increased significantly in the reporting period (from 60 in 2013 to 377 in 2021). All international students are full-time tuition fee paying students. Among international students, the country of residence with the largest numbers are India, France, Uzbekistan, Azerbaijan and Turkey. The number of Indian students has grown the fastest, from 5 in 2013 to 107 in 2021. The number of French students has been relatively stable at the beginning of the reporting period, it increased from 22 students in 2014 to 48 students in 2016, with French students subsequently taking advantage of mobility opportunities rather than full-time studies. The number of Uzbek students has increased from 17 in 2013 to 67 in 2020. The share of students from Azerbaijan started to increase in 2016 with 11 students, and by 2021 there were already 40 students from this country. The number of Turkish students has also increased during the reporting period from 4 to 35.

The number of mobility students in this study program has increased to 135 in 2021. The increase in the number of international and mobility students is due to both the reputation of the program and the expanded student attraction activities, for which the resources of RTU International Cooperation and Foreign Students Department (ICFSD) are being used. The ICFSD uses several types of information channels, choosing the most appropriate for each target audience: paid or advertising channels, public relations channels and its own channels. Marketing communication is an essential part of reaching out to foreign audiences, using all the classic marketing tools – advertising in the media and other channels, event marketing, direct marketing, digital marketing, etc. The main marketing tools used to reach foreign audiences are participation in various educational fairs and seminars organised by educational agencies in defined target markets. Since 2015, an average of 80 educational fairs and/or seminars organised by cooperation partners have been attended annually to promote study opportunities at RTU. During the pandemic period in 2020 and 2021, on-site exhibitions and seminars were replaced by virtual exhibitions and seminars, and in addition, “RTU Virtual Open Days” were organised every month, where foreign students studying at RTU FCSIT also shared their study experience. The continuity of information provision and promotion of studies abroad is ensured by long-standing cooperation partners in partner universities and educational agencies. To ensure that representatives of educational agencies and partners provide students with up-to-date and relevant information about studies, RTU organises an annual online training for partners; in 2019, such training was organised on-site, where partners had the opportunity to learn about RTU infrastructure, study opportunities, etc.

To ensure permanent presence of RTU in specific countries, thereby increasing RTU visibility and attracting more outstanding students, RTU opened RTU Information and Study Centre in Colombo (Sri Lanka) in 2016, followed by Chennai (India) and Tashkent (Uzbekistan) in 2019, and Ankara (Turkey) in 2020. RTU Information and Study Centres abroad have allowed RTU to monitor the level of knowledge and compliance with RTU requirements of admitted foreign students before their arrival in Latvia, as well as to reconcile the different Latvian and foreign secondary education systems.

The total number of student drop-outs has increased in close correlation to the increase in the total number of students. The majority of students are withdrawn for academic failure, which occurs when a student fails to complete the study course requirements for various reasons. This tendency is independent of the implementation language. The number of students withdrawn for academic failure in each academic year varies between 76 and 130. The highest dropout rates are observed in the first and second year of studies, which are mostly due to academic failure. A total of 855 students or 13% (see Annex 5) of the total number of students were withdrawn for failure during the reporting period. The majority of students were unsuccessful in fundamental courses (mathematics, physics, first programming courses), which shows that the knowledge acquired in these fields in the secondary school was insufficient. The high drop-out rate in academic year 2020/2021 was due to the COVID-19 pandemic. The second most frequent reason for dropping out among local students (and the third most frequent reason among foreign students) is voluntary. There are 11-36 such students each year. The most frequent explanation is the inability to combine studies with work commitments or other activities. But the second most frequent reason for dropping out among foreign students is not starting studies after matriculation (up to 19 students per year). No other clear trends have been identified; the reasons for extending studies or dropping out vary from year to year. It should be noted that in our specialisation, students in their second year are often employed on full-time basis in the sector and often away on long business trips. Other common reasons for dropping out are dropping out as a non-starter after academic leave (4-21 students per year), not starting studies after matriculation (4-25 students per year) or not attending classes (1-17 students per year, mostly among international students). Until 2020, up to 4 students are withdrawn each academic year for not fulfilling the agreement with RTU, but this number has increased in recent years due to the economic situation during the pandemic. Other reasons for dropout score less than 6 students per year.

When assessing the dynamics of students studying on the state budget and tuition fee paying students, it can be concluded that the number of students studying on the state budget is relatively stable (since academic year 2014/2015 it has fluctuated between 463 and 544 students), which is explained by the stable number of state budget funded seats during this period. On the other hand, the number of tuition fee paying students has increased significantly from 99 in 2013 to 476 in academic year 2021/2022. International students have made a significant contribution to this growth, with 377 in 2021.

Charts with statistical data on the number of students in the study program Computer Systems are available in Annex P05 “Statistics on students of the academic bachelor study program Computer Systems”.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Study program curriculum complies with Cabinet Regulations No 240 of 13 May 2014 “Regulations on the State Academic Education Standard”. The compliance is described in Annex P06 “Compliance of the academic bachelor study program “Computer Systems” with the State Education Standard”. The study courses included in the study program were developed in compliance with the valid normative acts: Cabinet Regulations No 322 of 13 June 2017 on the Classification of Latvian Education, the Law on Institutions of Higher Education (current version), RTU Study Regulations, Regulations of the Study Course Register and 27 May 2017 RTU Senate Decision on Evaluation of Learning Outcomes.

Study course descriptions are regularly updated in line with the needs of the industry, the labour market and trends in the field of computer science and information technology. Considering the rapid changes in the IT industry and technological developments, study courses are regularly updated and study program curriculum is modified, thus ensuring that the study program meets the needs of the labour market and the trends in the IT field. Some examples of changes:

1. The academic staff keep abreast of the use of programming languages and other technologies in the industry, adapting the languages and technologies used to teach the study courses accordingly. Considering the development of Python, Java and C# languages and their widespread use in the industry, the languages used in several study courses have been changed: “Algorithms and Methods of Programming” is taught using Python, “Algorithmization and Programming of Solutions” – using Java, while the study course “Programming Languages” includes C# and Python languages. Other modern programming languages, such as Kotlin, R and Matlab, are also used in other courses as well as in the graduation papers.
2. With the development of new data storage and retrieval technologies, new study courses on database technologies have been developed that incorporate both industry-standard NoSQL approaches and NewSQL concepts.
3. With the development of machine learning based approaches to artificial intelligence, the

content of the study course “Fundamentals of Artificial Intelligence” has been redesigned to include modern machine learning approaches.

4. To better train students to work in a project-oriented environment in the IT industry, the range of group projects in the study courses was extended, requiring students to work in teams to solve software development problems from the first year onwards.
5. Due to the high innovation capacity of the IT industry, the courses on foundations of economics previously included in the program have been replaced by the 4 CP study course “Innovative Product Development and Entrepreneurship”, so that students learn not only the theory of entrepreneurship, but also the practical processes required to create innovations.
6. In view of the growing global awareness of environmental and climate issues, the study program has introduced the study course “Environment and Climate Roadmap”.

The compulsory part of the study program includes study courses in the amount of 86 CP, which offer in-depth knowledge of the field of computer science in general and its formal foundations, develop the ability to choose appropriate methods for solving a problem, the ability to implement algorithms appropriate to the problem, use software development environments and tools.

As already described in 3.2.6 “Analysis and assessment of the topics of the final theses”, the academic and scientific staff of the Institute of Applied Computer Systems (IACS) follow the latest trends in IT research and propose topics for the final theses corresponding to them, accordingly involving students from the bachelor level in research fields relevant today.

Field-specific study courses build the technical knowledge base for practical problem solving and decision making in today’s changing software engineering environment. Students can choose field-specific study courses according to their professional interests, focusing more on software development, artificial intelligence or systems analysis.

The study courses in humanities included in the compulsory elective part of the study program and the group work included in the other study courses develop the social competences necessary for an IT professional, the ability to continue education and development, critical and creative thinking. Free elective study courses allow students to choose study courses according to their professional interests and needs.

Consequently, the aims, objectives and learning outcomes of all parts of the study program lead to the achievement of the learning outcomes and the overall aim of the study program, as well as the fulfilment of the tasks. Regular analysis and updating of study courses eliminate overlaps and duplication. The mapping of the learning outcomes of the study courses against the program learning outcomes is given in Annex P08 “Mapping of study courses for the study program “Computer Systems””. The mapping indicates that the learning outcomes contributing most to the first three program outcomes are related to basic knowledge and key skills in computer science and software engineering: has acquired knowledge in computer science in general and its formal basis (supported by more than 350 learning outcomes), is able to choose the appropriate algorithms (including ones for artificial intelligence), methods, software products and tools for solving problems (supported by more than 250 learning outcomes) and is able to use software development environments and tools as well as to develop software according to the best practice and standards of the IT sector (supported by more than 150 learning outcomes). This is due to the fact that these three outcomes cover very broad and fundamental areas. At the same time, the mapping also indicates that the other three outcomes are also achieved through study course learning outcomes. The outcome “is able to study professional literature in Latvian and foreign languages and use professional terminology in the state language” is supported by more than 100 study course learning outcomes, the outcome “is able to participate in project development, management, and work in a team, manage, plan and coordinate the working group following the interests of the society as a whole and principles of sustainable development" is supported by more than 70 study course learning outcomes and finally the outcome "is able to plan independently work activities" is supported by 25 study course learning outcomes. Although this is the smallest in terms of numbers, only relatively large projects teach students how to plan their work and time in practice, which are therefore few in number but still large enough in scope. In addition, in bachelor studies, a student must first learn the fundamentals and only then build on this knowledge to create larger projects that develop such skills as teamwork and time management. Detailed descriptions of each study course are given in Annex P10.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Teaching methods, study course structure and assessment methods are selected by the responsible instructor, according to the study course curriculum and program goals, as well as the needs of the students. The study work is divided into the following forms: lectures, practical classes, laboratory and independent work implemented individually and in groups, tests and graduation paper.

The aim of lectures is to ensure the acquisition of theoretical material of the study course. Lectures are organised for large groups, thus making efficient use of resources. Hybrid teaching methods are used to achieve the learning outcomes, combining verbal teaching methods, explanatory teaching methods, interactive teaching methods and demonstrative teaching methods. Various forms of feedback are actively used during lectures, including modern IT solutions such as student survey tools (e.g. https://www.mentimeter.com/, https://kahoot.it/, https://quizizz.com/), which also assist in implementing of emotional stimulation and appreciation methods. A flipped classroom approach is also used in some study courses, where students are introduced to the theoretical material before the lecture and the lecture is organized in the form of a discussion (discussions as a teaching method).

The aim of the laboratory work is to develop practical skills in the topics of the study courses using the laboratory equipment. In laboratory work, the academic staff combine a variety of practical teaching methods, including instructional and productive methods, as well as methods of teaching skills and methods for the use and strengthening of creativity, to achieve the objectives.

The aim of independent and practical work is to strengthen the theoretical knowledge acquired at the lectures by applying it to the analysis and solution of various tasks, situations and problems. To achieve the objectives, the academic staff use similar methods to those used in laboratory work, supplemented by problem-oriented methods and learning through discussions, but without the use of laboratory equipment.

Practical, independent and laboratory work is organised both individually and in groups, ensuring that students develop both their individual skills and the skills essential in the IT industry to work in teams, as well as to formulate and delegate tasks, and to present their results. Group work is organised in the following study courses: “Fundamentals of Computer Systems Design”, “Introduction to Study Field”, “Fundamentals of Artificial Intelligence”, “Systems Analysis and Knowledge Acquisition”, “Algorithmization and Programming of Solutions”, “Programming Languages”, “Algorithmization Practice”, “Software Evolution Technologies”, “Operating Systems”, “Applied System Software” and “Adaptive Data Processing Systems”.

The purpose of tests is to assess how students have acquired the theoretical knowledge and developed the relevant skills. Depending on the knowledge and skills to be tested, the following forms of assessment are used: assessment tests, test work, examinations and credit tests.

For graduation papers the research method is mainly used, but practical teaching method, the heuristic (discovery) teaching method and the skill-building teaching method are also applied. To develop discussion and presentation skills, as well as to discuss and promote the results of the graduation paper, students are offered the opportunity to participate in RTU Student Scientific and Technical Conference.

In academic matters, individual approach is ensured in accordance with RTU Academic Staff Work Planning Guidelines, which stipulate that the academic staff must ensure the availability of the necessary amount of counselling/tutoring to students. In addition, individual consultations are provided for the supervision of coursework and projects, internships and Bachelor Thesis. Pre-examination counselling is organised before examinations. If necessary, students can directly contact academic staff outside the tutorial hours by sending their questions in the form of messages or in the appropriate course forum in ORTUS system or by e-mail.

RTU e-learning environment ORTUS based on Moodle platform is actively used to support the study process, which contains study materials, knowledge self-assessment tools, task submission functions, testing functions, as well as video recordings of lectures that are used during the remote studies. The use of the e-learning environment is mandatory for RTU academic staff. The plagiarism detection software developed by IACS is used for submitted papers. All resources available in the e-learning environment can be used by the student at their own pace and according to their individual needs.

The appropriately chosen teaching methods allow implementing the study program in two languages - Latvian and English. The study program in the Latvian language is mastered by local students, while the study program in the English language is mastered by foreign students. To ensure the quality of studies, academic staff with at least B2 level of English are involved in the work with foreign students.

RTU considers all aspects of student-centred education in order to increase students’ motivation and improve the quality of their studies.

1. Student involvement in the study process and content development

In accordance with the procedures developed by RTU, students have opportunities to provide regular feedback on the study content. Students are regularly involved in the quality assessment of study programs and participate in the work of decision-making and advisory bodies. In addition to the formal processes, there are regular meetings between students and the head of study program to discuss the content and quality of the studies. There is a semesterly survey in which students give feedback on the study course as a whole. Students also have the opportunity to contact the head of study program or RTU Study Department at any time, where there is a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to software development and other IT processes, and link the outcomes to the study program learning outcomes and the study course volume in terms of credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (document, presentation, video recording, interactive learning materials, etc.). In the first year, for students with a low background knowledge in mathematics and basic programming, students are offered free elective study courses “Basic chapters of elementary mathematics” and “Algoritmization Practice”. For the graduation paper, the student has the right to propose their own topic, thus achieving the learning outcomes in a way that interests them.

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. RTU also regularly uses the opportunity to invite guest lecturers to share their experience with students in the form of individual guest lectures or complete study courses. By meeting guest lecturers in specially organised seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad. Further information on guest lecturers and academic staff mobility is given in section 3.4.1 “Assessment of the compliance of the qualification of the teaching staff members”.

4. Social dimension

Students studying in the study programme Computer Systems have sufficient flexibility to combine work/family life with their studies. This is demonstrated by the fact that most students have already started their career in speciality in the 2nd or 3rd year of their studies. As a positive fact it should be noted that RTU library is available to students 24 hours a day and also at weekends.

5. Teaching and learning methods

The teaching and learning methods described previously are used in the implementation of the study program and are adapted by the academic staff to the specific situation. Students have the opportunity to receive individual tutorials from the academic staff involved in the study program, including communication in the e-environment using RTU licences for Zoom and MS Teams platforms, as well as messaging services of the Moodle platform.

6. Learning environment

In 2021, a new FCSIT faculty building was opened in Zunda krastmala 10. Students have access to all the technical equipment needed for modern IT education - computer labs, including virtual computer labs. The new building has quiet working and relaxation areas on each floor. Modern videoconferencing tools such as Zoom and MS Teams licences for remote lectures and tutorials, as well as other software licences, including academic ones (e.g. MS Office, and various software development environments and tools) are also available. Classrooms also have the technical equipment to support hybrid learning, thus enabling foreign teachers to be involved in teaching a part of a course/lecture from a distance.

Throughout the implementation of the study program collaboration between librarians and academic staff is ensured, with the aim of improving teaching and learning process. In the first year of studies, students are introduced to the resources and databases available in the library. Following the modern demand, RTU Scientific Library is digitalizing, offering more and more resources in e-format, including the most important databases of scientific articles in the IT field (IEEE, SpringerLink, ACM, ScienceDirect, Wiley, etc.).

7. Academic staff competence development

The academic staff involved in the study program are provided with regular opportunities to develop their methodological and didactical skills. The competence development process of academic staff includes methodological seminars of the Institute of Applied Computer Systems and the Faculty on the use of teaching and learning methods, including innovative teaching methods, as well as RTU Methodological Conference. The following methodological seminars have been held in recent years:

- 20.02.2019. Academic Integrity and Work with International Students;
- 18.12.2020. Organisation of Remote Examinations;
- 12.02.2021. Implementation of Distance Learning;
- 12.03.2021. The Digital Age Student (Zanda Rubene, Professor, University of Latvia);
- 08.10.2021. Content of the Bachelor Thesis at the Institute of Applied Computer Systems;
- 28.01.2022. Academic Integrity at RTU and FCSIT;
- 25.02.2022. Formative Assessment: with and without technology (Anžela Jurāne-Brēmane, Researcher, Vidzeme University of Applied Sciences).

SAM 8.2.2 project provided the opportunity to do internships in IT companies, thus mastering the latest approaches and methods used in the industry in order to integrate them into study courses. The project also provided an opportunity to attract new academic staff, especially PhD students, to teach in the study program.

8. Extra-curricular activities for students

A wide range of extra-curricular activities are offered to the students of the study program:

- The study program and faculty management actively support and encourage students to participate in student self-government activities, thus allowing students to develop their independence, giving them the opportunity to implement their ideas, as well as opportunities for additional learning outside lectures.
- Every student at RTU is offered opportunities to participate in extra-curricular activities (sports teams, dance groups, choirs, etc.) organized by different RTU departments.
- Students are also involved in scientific work and research on topics relevant to the field, participating in both local and international projects, which also gives them the opportunity to participate in international conferences.
- Each year, a Student Scientific and Technical Conference is organised, where students have the opportunity to gain first-hand experience in publishing their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

During the reporting period, 466 young professionals graduated from the study program, fully completing the program requirements and elaborating a graduation paper.

The study program “Computer Systems” offers students both thesis topics related to traditional and fundamental approaches to software development, as well as topics related to the application and research of modern technologies and methods (including artificial intelligence). The Institute of Applied Computer Systems maintains productive collaborations with the companies in the industry, thus some students elaborate graduation papers on topics defined by the companies and relevant to the industry at the time. By elaborating a graduation paper in one of the areas listed below, the student becomes an expert in an area of relevance to the IT industry.

Artificial intelligence

Includes: machine learning, including deep neural networks, intelligent agent technologies, distributed intelligent systems, knowledge engineering, ontologies, intelligent robot and multi-robot systems, various tasks in robotics (interaction, self-localisation, navigation, mapping, task allocation), various applications of AI techniques, computer vision, natural language processing, affective computing and generative arts.

Data storage, search and processing technologies

Includes: latest database technologies: use of RDB, RODB, XML, JSON, NoSQL and object databases, personal and mobile database systems, big data storage and processing, data analysis and visualisation, data analysis methods and business intelligence methods, information retrieval technologies, web crawlers and search engines.

Systems theory, systems analysis, design, modelling and systems engineering

Includes: systems theory models and applications, systems analysis and design, continuous systems engineering, complexity control in information systems engineering, modelling of system structure and performance, design of information systems in different domains, design tools, topological functioning model, use and development of modelling languages, use and development of modelling tools.

E-learning systems

Includes: intelligent learning systems, software solutions for learning purposes (e-learning, m-learning, etc.).

Information systems security

Includes: information security and computer systems security, security methods and tools, cryptography, steganography, obfuscation, reverse engineering of code.

Software development technologies and programming languages

Includes: software development technologies, stages of software engineering, programming languages, object-oriented languages and methods, functional languages and programming, aspect-oriented languages and programming, mobile application development, software testing and test automation tools, computer game development technologies, DevOps, continuous integration and delivery, cloud computing, microservices architecture, model-driven software development technologies and tools, asynchronous programming, parallel programming, distributed systems development, Internet of Things systems.

Operating systems and systems programming

Includes: operating system design concepts, process processing and cooperation, distributed processing concepts, operating system security.

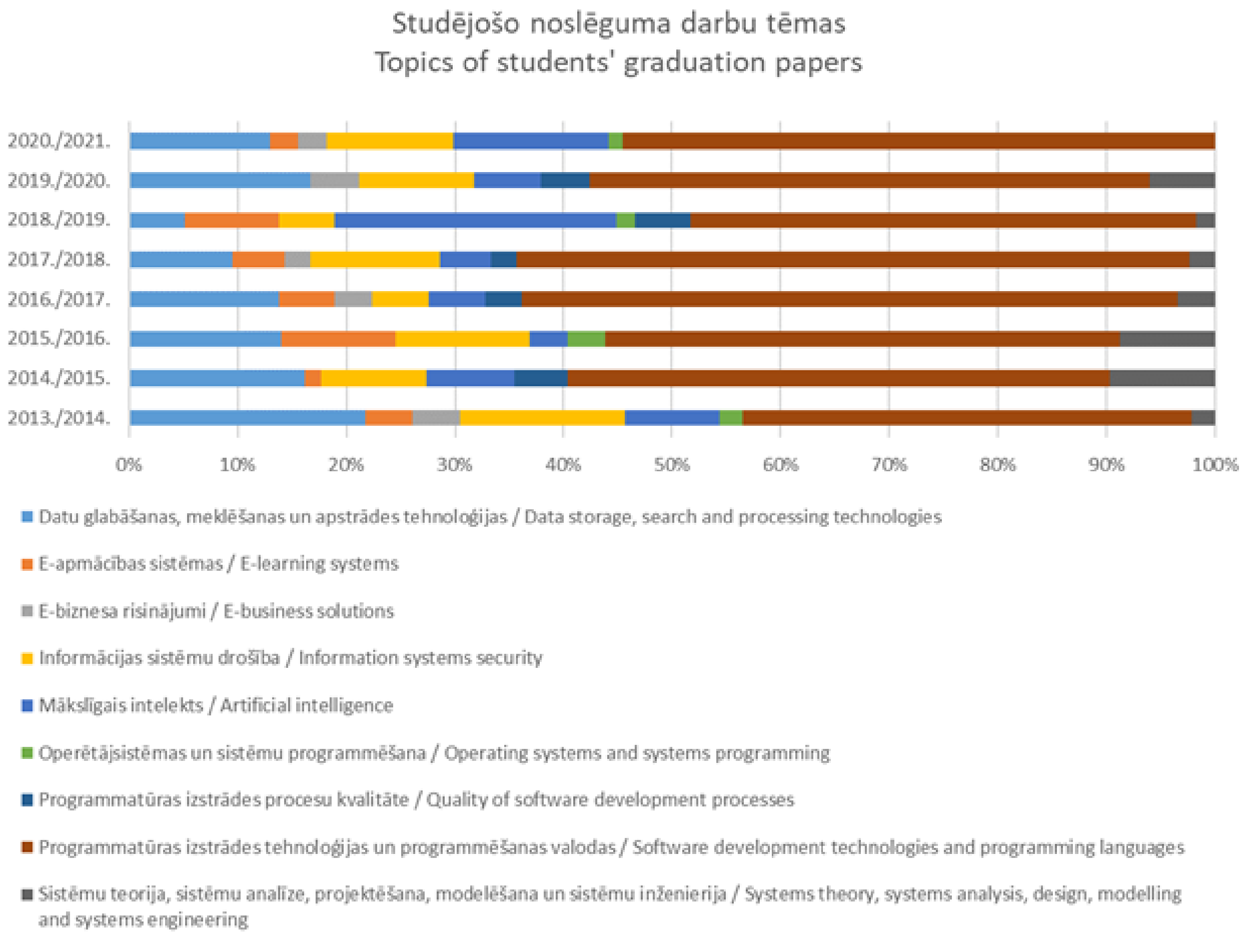
Quality of software development processes

Includes: traditional and advanced models of the software development life cycle, quality management models.

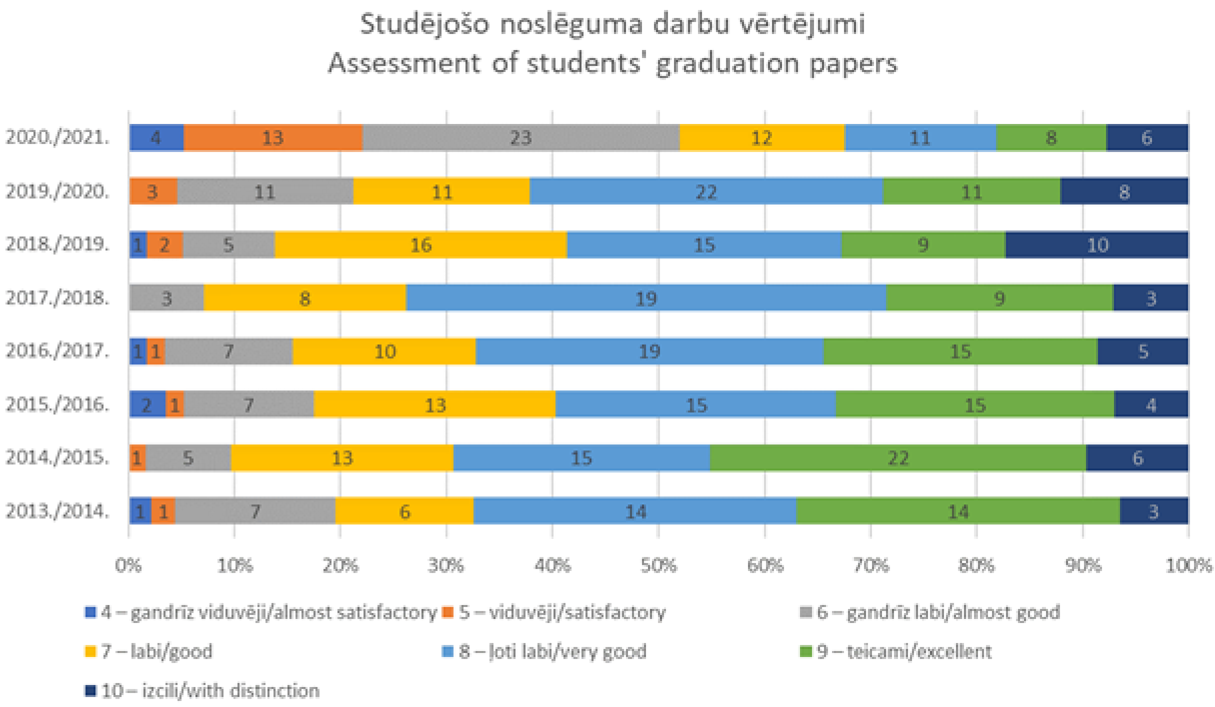
E-business solutions

Includes: blockchain technologies, payment processing system technologies, customer management solutions, notification system solutions, e-commerce systems.

The overall distribution of graduation papers by topic for each academic year is shown in the figure below. As can be seen, most graduation papers are written on topics that directly correspond to software development technologies and programming languages. This is because these topics correspond to the core of the program, which is to educate and train professionals in software development. However, a significant number of Bachelor Theses are also written on new technologies and models that are relevant today. In recent years, topics on various sub-topics of artificial intelligence and topics on modern data storage and processing technologies are the next two largest groups of topics. The total list of topics by year and the grades obtained by students are given in Annex 3.2.6 “Topics of students’ graduation papers”.



From 1 September 2020, changes have been made to the requirements for the graduation papers at the Institute of Applied Computer Systems, raising the quality of graduation papers and making the requirements the same for all academic bachelor study programs implemented at the Institute. The new requirements demand students to either research existing state-of-the-art IT solutions or develop their own solution, thus ensuring a thorough understanding of the field and the ability to continue working in both a research and industrial context on the topic. This explains the slight deterioration in the average grade the Bachelor Theses defended in 2021. The distribution of the grades obtained by students in each year is given in the figure below.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The following resources are used for the implementation of the study program:

- Auditoriums for lectures and practical classes. The study program is implemented at the Ķīpsala Campus, which has both FCSIT rooms and RTU joint use premises. The facilities are accessible for persons with disabilities. Available classrooms are described in Part II, Chapter 3, Section 2.3.2 - Resources and Provision of the Study Field.
- RTU information platform ORTUS and E-learning environment, which provide support function for information exchange between the faculty and students, the study process, available study course materials, posted and completed tasks, assessment tests, etc.
- Computer classes and computer labs, which are of particular importance given the specific nature of the program. The necessary software is purchased and installed in the computer labs appropriate for each study course, mostly academic licenses are used for specific software. 5 joint use computer classrooms (140 computers in total) are available at FCSIT and 5 specialized computer labs (150 computers in total) are available at the Institute of Applied Computer Systems. Windows, Linux, MAC and mobile computer classes are available. Computer labs provide students of the study program “Computer Systems” with equipment necessary for the development of group projects, laboratory works and research during their studies.

- FCSIT joint use computing centre, which provides access to computing resources in the cloud. Virtual computer labs are also available for students to use specific software remotely. Licensed Microsoft office software and software development tools are also available to students for learning purposes.
- Virtualisation services that allow students to obtain the computing resources they need for various tasks and experiments with the appropriate software and infrastructure, including a fixed internet connection.
- In 2015 FCSIT opened National Research Centre of Information, Communication and Signal Processing Technologies, where students have the opportunity to join programme-relevant research in fundamental and applied research in computer systems development, in particular but not limited to the development of their Bachelor Thesis.
- RTU HPC provides necessary computing power for resource demanding student research, for example, training deep neural networks.
- RTU Scientific Library.

The computer class equipment used in the study programme provides the full performance of laboratory and practical work using the current technical provision. A wide range of operating systems and technical solutions (Microsoft, Linux, Apple products) provides option to observe the operating and processing principles of software in different environments.

Mobile class (Android based devices) gives option to use digital materials and knowledge testing tasks during lecture time (interactive interaction tools that require predesigned configuration and increase the level of reliability of the identity of the task or knowledge test accomplished in the learning process).

IACS virtualization solutions provide option to integrate students' computers into the learning process, using a cloud-based solution available to students with a predesigned configuration that reduces the time for preparing the computer for performing a task.

In the study year 2018/2019, the computer classes and laboratory premises of the Institute of Applied Computer Systems for training and scientific research were occupied for 90% of available time.

RTU Scientific Library has a wide range of books and other resources appropriate for the academic bachelor study program “Computer Systems” (description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3.). Upon request of administration of the study program “Computer Systems”, 295 new books have been purchased in the period 2013-2021 for the amount of EUR 16024.64.

Part II, Chapter 3, Section 2.3.3 lists the e-resource collections available in RTU Scientific Library. The content of the following collections is most relevant to the specific nature of the study program “Computer Systems”: ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost Web, ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate), learning materials repository Merlot, Latvian Standards Database (available only in the library premises). There is also an interlibrary loan and resource sharing system, ExLibris, where students can order books and journals that are available in other libraries.

RTU has a wireless Internet connection for students, which enables students to study additional materials, participate in various interactive activities during the lectures, such as polls. The Institute of Applied Computer Systems also has the necessary equipment and software licences for remote work with students, as well as the possibility to provide hybrid work, where some students are in the room and some connect to the lecture remotely.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and facilities meet the conditions for the implementation of the study program and contribute to the achievement of the learning outcomes. The academic bachelor study program “Computer Systems” is implemented both as a study program with state budget financing, with 179 state budget funded seats, and as a tuition fee funded study program in Latvian, and as a tuition fee funded study program for international students.

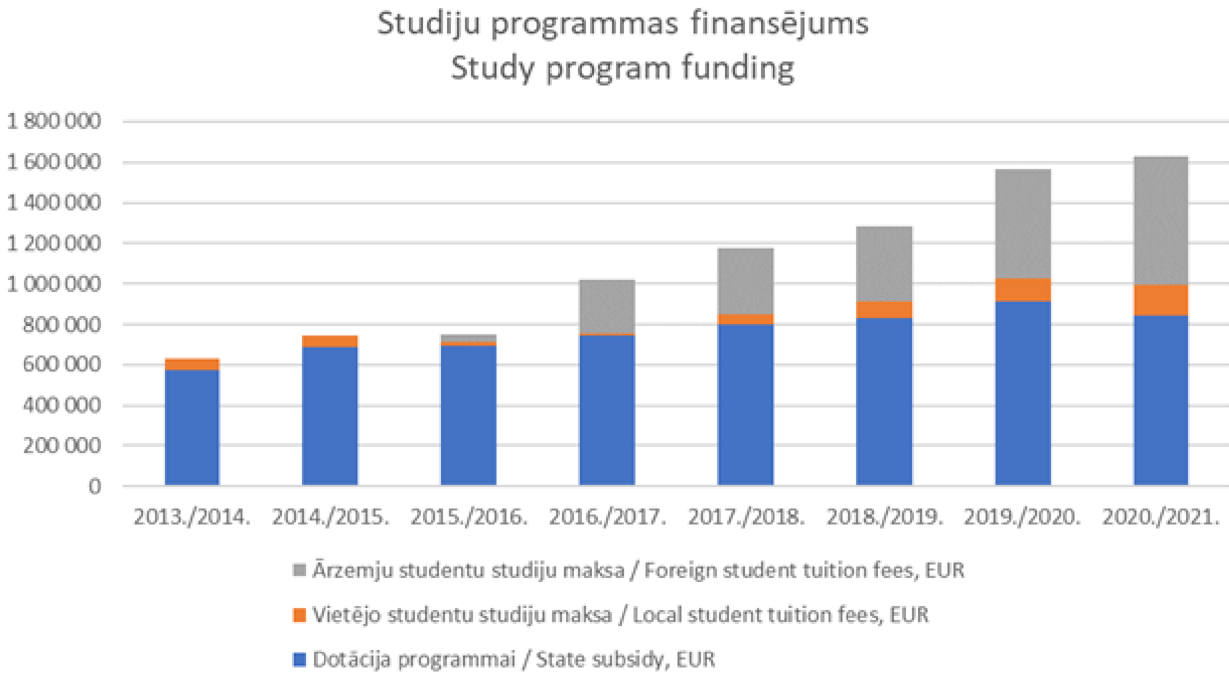
The data on funding are presented in the table below (see Table 3.1).

Table 3.1

Study Program Funding

Academic year	State subsidy, EUR	Tuition fees at the program, EUR		Total study program funding, EUR	Funding of one state budget funded seat, EUR
		Local student tuition fees, EUR	Foreign student tuition fees, EUR		
2013/2014	575 271	53 772	*	629 043	3 866
2014/2015	685 220	58 046	*	743 266	3 866
2015/2016	691 037	19 276	36 890	747 203	3 866
2016/2017	742 988	16 091	262 018	1 021 097	3 866
2017/2018	798 855	53 844	324 657	1 177 356	4 041
2018/2019	832 331	79 868	374 752	1 286 952	4 230
2019/2020	910 984	112 350	546 001	1 569 335	4 405
2020/2021	845 674	152 210	629 381	1 627 264	4 463

* Data on international students are not available for academic years 2013/2014 and 2014/2015. Considering the data on the number of students, it can be concluded that they were slightly lower than in academic year 2015/2016.



As shown in the table and the figure above, the academic bachelor study program “Computer Systems” has a steadily increasing total funding over the reporting period. It has more than doubled during the whole reporting period. When analysing the growth positions, it can be concluded that the state budget subsidy has increased the least. Meanwhile, income from tuition fees has multiplied. At the beginning of the reporting period, tuition fee income represented less than 10% of total revenue. Meanwhile, in academic year 2020/2021, tuition fees are already comparable to the state budget subsidy. The largest increase in income is directly due to fees paid by international students, which allows the full implementation of the study program in English. It should be noted that the volume of local tuition fee paying students and the tuition fees paid also increased threefold during the reporting period.

Based on the 2015 “Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation” conducted by the Ministry of Education and Science, as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study program, RTU has determined that the academic bachelor study program must have at least 19 students in each academic year. The academic bachelor study program “Computer Systems” exceeds this number several times both in Latvian and in English flows (both among local and international students). In 2021 the number of students per study year is 424, 235 and 297. In addition, the study program has joint study courses with the study programs “Information Technology”, “Automation and Computer Engineering”, as well as “Intelligent Robotic Systems”.

Information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the cost per student is given in the Annex “Breakdown of funding between cost items”. Information on the minimum number of students required for the study program is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study program”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study program comply with the conditions for the implementation of the study program and the requirements of the regulatory enactments. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The responsible instructor is appointed by the head of the responsible structural unit. Instructors responsible for study courses can be professors, associate professors, and assistant professors with a scientific degree in the relevant branch or sub-branch of science. All responsible instructors involved in the implementation of the study program “Computer Systems” hold a PhD degree. In total, 79% of the academic staff involved in the implementation of the study program hold a PhD degree. All lecturers have at least a Master’s degree in engineering or computer science, while practical and laboratory work is mostly carried out by academic staff with Master’s degree, but in some cases industry professionals with the necessary practical experience are involved. In total, 70 academic staff members are involved in the implementation of the study program.

Elected academic staff participate in the implementation of the study program, the election of which and the observance of the necessary quality requirements are regulated by the RTU Regulations No. 589 adopted on April 27 2015 “Regulations on the Procedure for Election of Docents, Lecturers and Assistants” and No 649 adopted on April 26 2021 “Regulations on the Procedure for Election of Professors or Associate Professors and Qualification Assessment of Professors and Associate Professors”, as well as the Rector's order on the procedure for evaluating the performance of professors and associate professors (No. 01000-1.1-e / 157 of 7 October 2021).

The number of PhD holders has increased during the reporting period. During the reporting period, four academic staff members of the study program Computer Systems have obtained their PhD degree - Assoc. Professor Aleksejs Jurenoks, Researcher Sintija Petroviča, Assist. Professor Gusts Linkevičs, Lect. Padmaraj Nidagundi, as well as researcher Ēvalds Urtāns who is the instructor of free elective study courses.

In study courses and topics where the IACS team lacks expertise, guest lecturers from IT companies in Latvia and abroad, as well as from foreign universities in Lithuania, Serbia, Slovakia and other countries are involved. Examples are summarized in the table below. In the framework of SAM 8.2.2 project, guest professor Miloš Stojmenovič was invited to introduce free elective study course on deep machine learning for computer vision solutions. IT industry professionals are widely involved in the implementation of the study courses. The number of academic staff involved in the implementation of the study program is 70; the number of guest teaching staff is 26 (total during the reporting period).

Summary on the involvement of the guest lecturers in program implementation:

Name, surname of the gust lecturer	Organization	Date	Study course, activity	Contact hours
Olga Jakovļeva	RP Ltd “Rīgas satiksme”	2019/2020	“Algorithmization and Programming of Solutions”, lectures and laboratory works	96
Yulia Yakovleva	*A1QA*, Belarus	2019/2020	“Basics of Software Functional Testing Automation”, lectures and laboratory works	64
Yulia Yakovleva	*A1QA*, Belarus	2020/2021	“Basics of Software Functional Testing Automation”, lectures and laboratory works	64
Yulia Yakovleva	*A1QA*, Belarus	2021/2022	“Basics of Software Functional Testing Automation”, lectures and laboratory works	64
Milos Stojmenovic	Singidunum University	02.2020 - 06.2020	Implementation of the free elective study course “Deep Learning Approaches to Computer Vision” (4KP)	64
Uldis Karlovs-Karlovskis	*Accenture* Latvian branch	29.01.2018 - 25.05.2018	“Instruction to DevOps methodology and tools”, practical classes	32
Čuvirovs Jevgēnijs	*Accenture* Latvian branch	11.02.2019 - 20.05.2019	“Automatic testing of web applications”, lectures and laboratory works	32
Čuvirovs Jevgēnijs	*Accenture* Latvian branch	11.02.2019 - 20.05.2019	“Basics of Software Functional Testing Automation”, lectures and laboratory works	32
Bazyleva Ekaterina	*A1QA*, Belarus	22.02.2017 - 20.04.2017	“Basics of Software Functional Testing Automation”, lectures and laboratory works	32
Mārtiņš Leitass	Emergn	2014/2015	Free elective study course “Programming Language JAVA”, lectures and laboratory works	32
Vladimirs Kotovs	JSC Citadele banka	2014/2015	“Applied System Software”, lectures and laboratory works	32
Vladimirs Kotovs	JSC Citadele banka	2015/2016 2016/2017 2017/2018	Free elective study course “Programming Language JAVA”, lectures and laboratory works	32
Vladimirs Kotovs	JSC Citadele banka	2017/2018 2018/2019	“Functional Programming”, lectures and laboratory works	32

Evija Vaščenko	JSC Citadele Openmind	2016/2017 2017/2018 2018/2019	Free elective study course "Mentor Program", lectures and practical classes	32
Iļja Germans	EIS Group Ltd "Blockvis"	2019/2020 2020/2021 2021/2022	"Functional Programming", lectures and laboratory works	32
Uldis Karlovs-Karlovskis	*Accenture* Latvian branch	28.01.2019 - 24.05.2019	"Instruction to DevOps methodology and tools", practical classes	16
Edgars Biezaitis	*Accenture* Latvian branch	28.01.2019 - 24.05.2019	"Instruction to DevOps methodology and tools", laboratory work	16
Rocque Swathi-Christina	Accenture Latvija	20.09.2017.-29.11.2017	Guest lecture on the models used in systems analysis within the study course "Systems Analysis and Knowledge Acquisition"	16
Vladimirs Ņikuļšins	*Syniti*	15.10.2021	"Software Evolution Technologies", lecture "Enterprise Resource Planning implementation types on example from SAP"	4
Peter Pocta	Žilina University, Slovakia	30.01.2018 - 01.02.2018	Guest lectures on ensuring voice and sound quality in communication networks	4
Aleksejs Grocevs	Ltd Bilderlings Digital	21.04.2018	Guest lecture within the study course "Data Structures"	2
Gints Kļaviņš	Accenture Latvia	08.11.2017 09.11.2017 22.10.2015	Lecture "Application of Java technology" within the study course "Algorithmization and Programming of Solutions"	2
Jānis Olekšs	Accenture Latvia	23.03.2017	Lecture "Networking" within the free elective study course "Mobile Application Development for Android Platform"	2
Padmaraj Nidagundi	Ltd "Eptron"	07.03.2017 14.03.2017	Guest lecture within the study course "Applied System Software"	2
Aleksandrs Niedre	Accenture Latvia	03.11.2016 04.11.2016	Lecture "(Real) Life of a PHP developer" within the free elective study course "PHP Language for Development of Interactive Web-applications"	2
Andrejs Oliņš	Gazelle LLP	06.10.2016	Lecture "Java technologies" within the study course "Algorithmization and Programming of Solutions"	2

Andrejs Oliņš	Gazelle LLP	19.10.2016	Lecture “Programming Language Scala” within the study course “Programming Languages”	2
Dāvis Štegmanis	Accenture Latvia	05.11.2015	Lecture “Application Development in IT Enterprises” within the study course “Algorithmization and Programming of Solutions”	2
Padmaraj Nidagundi	Ltd “Eptron”	16.05.2016	Lecture “About Software Development & Testing” within the study course “Applied System Software”	2
Uldis Indriksons	Accenture Latvia	14.04.2016	Lecture “Reading data from the network in mobile apps” within the free elective study course “Mobile Application Development for Android Platform”	2
Ilze Auziņa	UL Institute of Mathematics, Artificial Intelligence Laboratory	31.10.2019	Guest lecture “Artificial Intelligence in Humanities" within the study course "Foundations of Artificial Intelligence"	2
Bozhikov Asen	D.A. Tsenova Academy of Economics	04.04.2017	Guest lecture within the study course "Fundamentals of Computer Systems Design "	2
Saulius Gudas	Vilnius University, Lithuania	05.05.2016	Guest lecture on business process management and engineering within the study course “Systems Analysis and Knowledge Acquisition”	2
Jānis Plūme	Ernst&Young Baltics	12.11.2019	Guest lecture "Data Analysis Tool Easy BI" within the study course “Database Management Systems”	2

To ensure and improve the quality of studies, academic staff of FCSIT actively participate in various professional advancement activities. Training and qualification improvement are carried out through participation of academic staff in conferences and seminars, studying in various courses, participation in the work of other organisations, practical work as experts and consultants. RTU provides access to edX and Coursera study courses in the areas of interest to the academic staff. RTU organises an annual methodological conference, which is regularly attended by the academic staff of the Institute of Applied Computer Systems as listeners and presenters.

A particular highlight is the Buffalo Program, launched in 2019, which brings academic staff members to the State University of New York at Buffalo, USA for a semester-long internship. Currently, the following academic staff members of academic bachelor study program “Computer Systems” have completed the internship process: Professor Marina Uhanova, Associate Professor Alla Anohina-Naumeca, Associate Professor Katrina Boločko, lecturer Andris Ozols, lecturer Māra Pudāne and lecturer Ainārs Auziņš. For the academic staff members involved in the implementation of the study program there is also an opportunity to undertake internship in Latvian IT companies within the SAM 8.2.2 project.

The compliance of academic staff with the requirements for the implementation of study courses is confirmed by the data included in the CVs of academic staff and their research results (scientific projects, publications, presentations at scientific conferences, as well as contractual work). In accordance with the Law on Higher Education Institutions, academic staff also carry out research activities in the relevant field at the same time as their work in the study process. Academic staff are free to choose their field of research and to propose appropriate topics for graduation papers. In 2021 International Evaluation of Scientific Institution Activity, RTU Faculty of Computer Science and Information Technology was awarded a four-point rating.

~70% of the elected academic staff of the Institute of Applied Computer Systems hold a PhD. A number of academic staff members are also employed in IT companies and thus transfer practical skills and competences to the study program.

Brief summaries of the academic staff activities are given below.

Assoc. Prof. Egons Lavendelis

Head of the study program "Computer Systems". Research in artificial intelligence, focusing on multi-agent systems, software for control of multi-robot systems based on intelligent agents and systems theory. E. Lavendelis has 42 publications in the corresponding field of research (14 of them in the last 6 years) and has participated in 18 research projects (7 of them in the last 6 years), including FP7 and ERA-NET international projects, and has been a scientific leader or RTU research team leader in 3 projects.

Assoc. Prof. Alla Anohina-Naumeca

Primary research area: intelligent learning systems that use artificial intelligence methods to ensure personalised learning process. She has published three research papers in this area in the last six years. She has completed a contract with the IT Education Foundation to develop the content structure of a free online open access study course in artificial intelligence, and at RTU has developed a massive open online course in artificial intelligence, "Artificial Intelligence: Search and its Applications". In 2020, she completed AI-related courses demonstrating the highest results during her internship at the State University of New York at Buffalo, USA. She has obtained certificates in professional advancement courses "Artificial Intelligence for Everyone" (Coursera), "Elements of Artificial Intelligence" (University of Helsinki) and "Mind and Thinking from a Cognitive Science Perspective" (UL Open Minded).

Prof. Jānis Grundspeņķis

Implements study courses related to artificial intelligence and systems theory. His latest research involves work on four projects: complexity analysis of concept maps from a systems theory perspective, the use of ontologies in competency management, future robotics technologies, and event-based computer vision.

Prof. Mārīte Kirikova

Her research interests are mainly related to requirements engineering. Research is focused on models for representing the context of information systems and the development of a continuous requirements engineering framework to ensure the flexibility of the requirements engineering process. Recent research is related to incorporation of data analytics into the requirements engineering process. During the last six years, she has participated in 4 international and 5 local projects. The results of scientific research over the past six years have been published in more than 75 publications.

Prof. Oksana Ņikiforova

Within the context of the topics of the implemented study courses (software design and development technologies, innovative product development and entrepreneurship, etc.) she has published more than 100 scientific articles and has participated in more than 30 scientific projects, as well as has long-standing industrial experience in software development projects.

Assoc. Prof. Ērika Nazaruka

Her scientific publications are related to the formalisation of the software development process, which allows quality control measures to be taken at the system analysis stage. She has completed the course in automation of software functional testing implemented by Accenture Latvian branch. Maintains close cooperation with A1QA (representative in Latvia "Planet of Testing" LLC) and Accenture Latvian branch representatives is organised in the implementation of the study courses.

Assoc. Prof. Gundars Alksnis

Long-standing academic experience, participation in the implementation of the study course "Object-Oriented Programming" since 2005 and following industry trends, provide competences not only to teach object-oriented programming from a modern perspective, but also to emphasize its historical development. Academic experience in the implementation of the study course "Computer Organization and Assembly Language" since 2013 and interest in assembly language provide the competences to explain the principles of computer functioning and the need to know them in the modern context. Programming experience in both the object-oriented paradigm and assembly language was also gained from the previous work in the IT industry.

Assoc. Prof. Katrina Boločko

She is the author of eight scientific articles and worked on five scientific projects related to the subjects of her study courses (image processing, computer graphics and computer vision). For the purpose of professional advancement, she participated in the Buffalo program for Latvian academic staff, during which she attended courses related to image processing and computer vision.

Prof. Marina Uhanova

In the last six years, she has published 12 scientific articles and participated in one scientific project related to the study courses she implements (software development and testing). In 2019, she completed an internship at the State University of New York at Buffalo, USA for the purpose of professional advancement, and mastered three Coursera courses: "Text Retrieval and Search Engines", "Programming for Everybody (Getting Started with Python)" and "Python Data Structures".

Assoc. Prof. Pāvels Rusakovs

In the last six years, he has published three scientific articles dealing with some of the problems of the Semantic World Wide Web and the use of video steganography for copyright protection.

Assist. Prof. Vita Šakele

In the last six years, she has participated in two research projects and has published one scientific article related to the topics of her study courses. She has successfully completed several online training courses in data visualisation and artificial intelligence on Coursera and Udacity platforms.

Assoc. Prof. Natālija Prokofjeva

She conducts research on assessing student knowledge and personalising e-learning. She has participated in professional advancement courses "Methodology of teaching the module of new product creation and development" and "Conflict resolution skills". She is the author of 24 scientific articles on the issues of improving the learning process.

Lect. Svetlana Jurenoka

She has published three scientific articles in the last six years. For the purpose of professional advancement, she completed four Coursera courses (“Introduction to Artificial Intelligence”, “Software Development Lifecycle”, “Software Product Management”, “Excel/VBA for Creative Problem Solving, Part 2, Part 3”) and a Future Learn course “Artificial Intelligence for Earth Monitoring”.

Assist. Prof. Imants Gorbāns

In the last six years, he has published three scientific articles related to his study courses (operating systems). In 2020, he received a certificate for the Coursera course “Google Professional Certification - IT Security: Defence against the digital dark arts”.

Prof. Kārlis Šadurskis

In the last six years, he has participated in one research project and published three scientific articles related to the topics of his study courses (probability theory and mathematical statistics, random processes).

Sen. Researcher Andra Blumberga

A. Blumberga is an expert in system dynamics modelling for macroeconomic research on energy efficiency and renewable energy sources. Author of more than 130 scientific articles, she works on various regional and international projects focused on efficient use of natural resources, increased energy efficiency and environmental protection in buildings and energy sector.

Prof. Andrejs Koliškins

In the last six years, he has led one research project and published 21 scientific articles related to the study courses he implements (tasks on stability of fluid flows requiring the use of numerical methods: calculation of eigenvalues and numerical solution of ordinary differential equations).

Sen. Researcher Gaļina Merkurjeva

In the last six years, she has published three scientific articles on the subject of her study courses (systems modelling and simulation) and has acted as an external expert for the evaluation of international project applications in three competitions in Germany, Spain and Poland.

Sen. Researcher Ilmārs Iltiņš

In the last six years, he has participated in two research projects and published five scientific articles related to the subject of the study courses he delivers (numerical methods).

Assoc. Prof. Oksana Pavļenko

In the last six years, she has published two scientific articles and two teaching aids related to her study courses (probability theory and mathematical statistics). Member of the Latvian Statisticians’ Association. Member of the Latvian Mathematical Society.

Sen. Researcher Vitālijs Boļšakovs

In the last six years, he has published three scientific articles and participated in three scientific projects related to the subject of the study courses he delivers (fundamentals of system modelling and simulation).

Assist. Prof. Vineta Minkēviča

In the last six years, she has participated in four research projects and published two scientific articles on the subject of the study courses she delivers (Introduction to Operations Research).

Assist. Ainārs Knoks

A. Knoks works at the Institute of Solid State Physics, University of Latvia, researching the application of nanostructured materials in the power industry, focusing on the synthesis and research of titanium dioxide as a photocatalyst. He has worked on the projects investigating the influence of material synthesis parameters on the properties, catalytic materials for CO2 reforming in ethylene, and waste aluminium as an energy source.

Lect. Jānis Amoliņš

Within the State Education Development Agency project "Adult Education", he implemented a web development study course that includes the entire software development cycle and documentation. He has worked in the industry on software development projects, which allows him to explain students not only the theory but also the practices used in the industry.

Lect. Padmaraj Nidagundi

In recent years, he has been working in the field of software development and testing, where he has gained considerable international industrial experience, which allows him to implement study courses related to software development processes. Author of 11 scientific articles.

Prof. Inta Volodko

Participated in the Latvian Council of Science project "Analysis of complex dynamical systems in fluid mechanics and heat transfer". In the last six years, she has published 27 scientific articles, 17 of them related to the teaching of mathematics at the university level. Teaching skills have been improved by attending the course "Introduction to Engineering Pedagogy" at Tallinn University of Technology.

Researcher Sintija Petroviča

The implemented study courses are related to systems theory and systems thinking. In November 2021, a professional certificate was obtained after mastering the course "Human-Computer Interaction", which included topics on feedback, which is important in the context of control and dynamics, as well as topics on problem-solving methods and evaluation of alternative solutions, human thinking, mental models and their role in designing large systems or solving complex problems.

Lect. Ainārs Auziņš

In the last six years, he has published three scientific articles and participated in two research projects. Professional advancement: RTU, RBS and UL courses financed by the European Regional Development Fund, project "Support for RTU international cooperation projects in research and innovation" at the State University of New York at Buffalo, USA. Topics mastered: DBMS, Big Data Technologies.

Lect Māra Pudāne

Participated in the scientific project "Rethinking robotics for the robot companion of the future", where she performed data analysis. In 2020 completed two graduate level courses at the State University of New York at Buffalo, USA: "Data Models and Query Languages" and "Data Intensive Computing". Both courses are equivalent to 4 credit points in Latvian system (3 credit hours in the U.S.A. system).

Assoc. Prof. Jeļena Pundure

Research field: social and economic geography, economics and entrepreneurship. From 2015, she is an expert of the Latvian Quality Agency for Higher Education. Head of the ERASMUS+ project “Needs-based education and studies in societal security”. Researcher of INTERREG project “Development of a common environmental risk plan for Jelgava and Šiauliai”. In the last six years, she has published 13 scientific articles. Regular participant in professional advancement seminars (more than 30 in total).

Prof. Elīna Gaile-Sarkane

Author of more than 100 scientific papers published in Latvian and English, including 2 scientific monographs and 2 patents, as well as the author of 2 textbooks. She is participating in the scientific and editorial boards of scientific journals and has been the author of more than 50 scientific articles published in scientific journals and international conference proceedings (Scopus Hirsch Index 7). Pedagogical work: scientific advisor of 6 successfully defended doctoral theses; at the moment she is the advisor and consultant of several doctoral students. She teaches study courses in the areas of innovation management, strategic and change management, business and company management, etc. She is a Latvian Council of Science expert in 2 sub-sectors of Social Sciences and the Chairwomen of the Promotion Council “RTU P-09”.

Prof. Uldis Sukovskis

In the last six years he is the author of 5 scientific articles.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

One of the challenges that had to be addressed during the reporting period has been to renew the academic staff, which has been achieved by replacing retiring colleagues with new qualified academic staff. At the start of academic year 2016/2017, the average age of the elected academic staff of the Institute of Applied Computer Systems was 49.8 years, while at the start of the academic year 2021/2022 it was already 47.7 years. However, the overall structure of the academic staff during the reporting period is considered to be stable.

Generally, young colleagues start their career at the Institute of Applied Computer Systems already during their studies (final semesters of bachelor studies or master studies) by getting involved in one of the research projects implemented at the Institute. Students who perform well during their studies are offered the opportunity to continue their studies in the PhD program and to get involved in the teaching process, initially as assistants, and later during their PhD studies as a full-fledged lecturer for undergraduate students. This mechanism of attracting new academic staff has proven to be very useful in terms of assessing potential candidates during their studies and reaching out to students with the qualities and skills required for academic work.

Currently, 18 of the 26 elected academic staff members at the Institute of Applied Computer Systems hold PhD degree, representing ~70% of the elected academic staff.

The field specific study courses are mostly implemented by the academic staff of the departments within the Institute of Applied Computer Systems, whose composition has undergone relatively little change. The changes have been made with one of two objectives:

1. to change the academic staff of a study course in order to improve or modernise the content of the study course. Such changes are based on student feedback and evaluation of the

course content. For example, one of the courses in spring 2019 had received overall rating 46%, after change of the academic staff in spring 2021 it had increased to 81%.
2. to change the academic staff of a study course who is temporarily or permanently unavailable for the implementation of a particular study course for any reason due to retirement, change of job, or other reason.

Regardless of the reason for the replacement, it is taken into account that the quality of the implementation of the study course must not be reduced by the arrival of a new academic staff. This ensures the quality of the implementation of the entire study program

At the Department of Artificial Intelligence and Systems Engineering (at the beginning of the reporting period referred to as the Department of Systems Theory and Design):

- to reduce the workload of Professor Jānis Grundspeņķis, part of the study courses is implemented by Assoc. Professor Alla Anohina-Naumeca ("Introduction to Study Field", "Fundamentals of Artificial Intelligence"), Assist. Professor Vita Šakele ("Bachelor Thesis"), Professor Mārīte Kirikova ("Fundamentals of Computer Systems Design"), as well as researcher Sintija Petroviča ("Methods of Systems Theory"). No significant changes in student feedback have been observed.

At the Department of Software Engineering:

- Instead of Professor Jurijs Lavendelis, the study course "Algorithmization and Programming of Solutions" is implemented by Professor Marina Uhanova. The new skills and competences acquired by Marina Uhanova were used, which were acquired during the participation in so-called "Buffalo" program, which provides academic staff training at the University of Buffalo, USA. Since the change of the teacher, a markedly positive change in student feedback has been observed.
- The study course "Algorithms and Methods of Programming", where Professor Jurijs Lavendelis is the responsible instructor, is implemented by lecturer Valdis Saulespurēns. Since the change of the teacher, a markedly positive change in student feedback has been observed.
- Instead of Professor Leonīds Novickis, several study courses are implemented by Assoc. Professor Aleksejs Jurenoks. No significant changes in student feedback have been observed.
- Instead of Professor Larisa Zaiceva, the study courses "Software Engineering" and "Bachelor Thesis" are implemented by Assoc. Professors Natālija Prokofjeva and Aleksejs Jurenoks and, respectively.
- Instead of Assoc. Professor Eleonora Latiševa, the study course "Operating Systems" is implemented by Assist. Professor Imants Gorbāns (formerly Guest Assistant Professor). No significant changes in student feedback have been observed.
- Instead of Assoc. Professor Vjačeslavs Šitikovs, Assoc. Professor Aleksejs Jurenoks is responsible for the study courses related to Applied Software Automation. No significant changes in student feedback have been observed.
- Instead of lecturer Jekaterina Bule, the study course "Programming Languages" is implemented by Professor Marina Uhanova. The new skills and competences acquired by Marina Uhanova were used, which were acquired during the participation in so-called "Buffalo" program, which provides academic staff training at the University of Buffalo, USA. No significant changes in student feedback have been observed.

There have been no changes in the team of leading academic staff at the Department of Applied Computer Science. Associate Professor Gundars Alksnis has joined the study course "Computer Organization and Assembly Language".

The general foundations of computer science are provided by other departments of the Faculty of Computer Science and Information Technology. Main changes:

- Instead of Professor Aleksandrs Glazs, the study course "Fundamentals of Computer Graphics and Image Processing" is implemented by Assoc. Professor Katrina Boločko.
- Instead of Professor Kārlis Šadurskis, the study course "Probability Theory and Mathematical Statistics" is implemented by Assoc. Professor Oksana Pavļenko.
- Instead of Professor Valērijs Zagurskis, the study course "Computer Networks" is implemented by Assoc. Professor Dmitrijs Bļizņuks.
- Instead of Professor Zigurds Markovičs, the study course "Basics of Computer Control" is implemented by Assoc. Professor Dmitrijs Bļizņuks.
- In 2020, a field expert, lecturer Andris Ozols was recruited for the implementation of the study course "Innovative Product Development and Entrepreneurship", which allowed enriching this study course with the practical experience of the lecturer.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

The fundamentals of engineering, as well as study courses in humanities and economics, are provided by other RTU organizational units:

- Instead of Assoc. Professor Alvars Baldiņš, several study courses of the humanities block are implemented by Assistant Professor Aleksejs Šņitņikovs.
- Instead of Assoc. Professor Ludmila Vasiļjeva, study courses in the field of economics are implemented by Professor Irina Voronova.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

At the same time, rigorous quality control is applied to the implementation of the study courses. The primary source of information is student feedback. A trust-based cooperation with the student self-government has been established, so that students can approach not only the head of the study program but also their peers in the student self-government, who in their turn inform the head of the study program. All student complaints are promptly assessed and discussed with the academic staff. If it is found that academic staff is unsuitable to implement the study course in question, new academic staff members are sought.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

When defining the curriculum of a study course, the responsible instructor, in collaboration with the head of the study program, assesses the role of the study course in the study program, considering the required background knowledge and providing the necessary foundations for the subsequent courses. All changes in the study program, as well as significant changes in the study courses, are discussed in the Council of the Institute of Applied Computer Systems, which is composed of the heads and representatives of all departments within the Institute. Representatives of each organizational unit consider proposed changes from the perspective of their unit's courses. As soon as a link between study courses is identified, a working group is set up, involving the head of the study program, the responsible instructors of all the courses involved and, where appropriate, the heads of the departments implementing the courses. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The result is that the responsible instructors of all study courses are informed about the curriculum and expected learning outcomes of thematically related study courses, thus avoiding overlapping between the study courses and also the omission of important topics from any of the courses in a given field. Changes to the general part of the study program are discussed with the heads of the departments or responsible instructors of the study courses concerned.

In order to get a precise idea of the curriculum, teaching methods and terminology used in colleagues' courses, it is possible to attend their lectures. In order to ensure quality, the study courses are peer observed by another lecturer, thus taking over the good practices and providing feedback to the study course implementer. Open lectures are also organised for the academic staff. Methodological seminars are regularly organised at both Institute of Applied Computer Systems and Faculty level, where academic staff share their positive experience, which helps all academic staff to cope with new challenges. One of the situations when this was particularly relevant was the transition to remote studies at the beginning of the COVID-19 pandemic. In addition to the new circumstances, academic staff also share their experience on other issues such as students' academic integrity, graduation papers, conflict resolution, changes in the approaches of today's young people to their studies, etc.

In response to the changes in the procedures, official documents, organisation of studies the most appropriate approach to the nature of the change is chosen, for example by organising an information seminar or sending out detailed information about the changes and who to contact for further information.

In general, new academic staff start their academic career at the Institute of Applied Computer Systems by supervising practical and laboratory work or assisting at the lectures. Initially, new academic staff work under the guidance of experienced colleagues, meeting regularly with the responsible instructors to coordinate the content of the classes and the teaching methods to be used, thus ensuring knowledge transfer between the academic staff involved in the implementation of the study program.

The cooperation between the responsible instructor and other academic staff involved in the implementation of the study course plays an important role in ensuring the quality of studies. All academic staff involved in the implementation of the study course have access to teaching materials prepared by the responsible instructor, which can be used both in the classroom and in e-learning courses. Responsible instructors and other experienced academic staff members are also available for consultation on pedagogical methods to be used in the courses, as well as on other issues that arise for new academic staff.

The head of the study program monitors the implementation of the program and the cooperation between the academic staff. One of the tools for identifying problems is student survey that is conducted every semester. If students point out deficiencies in this survey, the head of the study program organises a meeting between all the academic staff involved with the aim of finding a solution to the problem.

The study program is implemented by 55 academic staff members who hold a PhD degree, including 10 professors and 12 associate professors. The number of students per academic staff in the study program is 9.35.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DBD0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DBD0(43526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DBD0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DBD0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DBD0(43526)_CompliancewiththeStateEducationStandard_AkadBak_ENG.pdf	P06_3.2.1_DBD0(43526)_AtbilstibaValstsStandartam_AkadBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DBD0(43526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DBD0(43526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DBD0(43526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DBD0(43526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DBD0(43526)_StudyCoursesdescr_ENG.zip	P10_DBD0(43526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Intelligent Robotic Systems (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Intelligent Robotic Systems*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Agris*
Surname of the study programme director	*Ņikitenko*
E-mail of the study programme director	*Agris.Nikitenko@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089550*
Goal of the study programme	*The aim of the academic Master study programme “Intelligent Robotic Systems” is to prepare professionals who can be characterized by ability to think systematically, to analyze, develop and implement technically and economically reasoned robotic and intelligent system solutions that promote application of these solutions to ensure organizations’ labor productivity increase and growth, as well as to develop students’ ability to carry out scientific work, to participate in local and international projects and to continue studies at Doctoral study programmes.*
Tasks of the study programme	*To achieve the aim set several tasks of the study programme are defined, as well as indicators of their fulfillment. They are reflected in the Table below: 1)To develop students’ systems thinking ability and practical skills that are necessary for development of the technically and economically reasoned robotic and intelligent system solutions 2)To use in the study process both fundamental and classical solutions and the latest achievements in robotics and artificial intelligence. To promote students' individual and practical work, as well as direct communication and work in groups 3)To provide knowledge and experience provision for students in several areas by cooperation with teaching stuff from different departments of Riga Technical University (RTU) 4)To assure the flexibility of the study program and the possibility to modify it in order to follow changes in the labor market and new developments in Information and Communication Technology (ICT) 5)To ensure learning outcomes defined for the program listed below 6)To develop cooperation with similar or topic-related programs in other countries within ERASMUS and other agreements 7)To stimulate in students desire to participate in implementation of scientific research 8)To prepare and motivate students for their Doctoral studies*

Results of the study programme	*According to the learning outcomes defined for the "Intelligent Robotic Systems" study programme, the graduates of the programme will:* *1) be able to develop solutions to particular problems by using modern automatic and electric drive elements;* *2) be able to develop an automatic or robotic system's control algorithm;* *3) be able to develop software for a specific robotic or automatic equipment management and coordination;* *4) be able to develop solutions that combine hardware and software technology advantages;* *5) know how to distinguish problems that should be solved with the hardware resources from those which should be solved with software resources;* *6) know how to identify problems that can be solved with intelligent robotic systems;* *7) be able to independently acquire new knowledge and skills;* *8) be able to work in group to achieve common goals;* *9) be able to substantiate the specific solution's advantages or disadvantages to the customer or to another professional;* *10) know how to identify the robotic systems' development project objectives that can be resolved using the available robots and artificial intelligence technology;* *11) know how to choose the most appropriate robotic intelligent system solutions to solve particular problems;* *12) know how to use advanced robotic systems' modeling tools to develop and approbate solutions for a particular problems;* *13) be able to assess the suitability of artificial intelligence methods for solving particular problems;* *14) able to formulate a particular problem in robotic, intelligent and automatic systems' terms, and vice versa;* *15) be able to provide compliance to professional and general ethic rules within their scope of authority;* *16) able to participate in local and international scale research projects devoted to intelligent robotic systems, as well as to manage them;* *17) able to manage the development of a technical solution or implementation of the projects;* *18) be prepared for their Doctoral studies.*

Final examination upon the completion of the study programme	*The results evaluation system is based on RTU Learning Outcomes Evaluation Regulations (Minutes no. 539) approved on March 29, 2010. The evaluation methods for each subject are defined by the responsible academic personnel (teacher) according to study course goals, tasks and applied teaching methods. The evaluation methods are known to students at the beginning of the semester. Some of the evaluation methods used by teachers are as follows: 1) written or oral examinations during the session; 2) written or oral individual work, the learning outcomes of which can include a presentation; 3) project that can be evaluated according to the student's contribution to group work; 4) regular tests during semester; 5) combination of the previously mentioned methods; Assessment of each subject is determined according to 10 grade scale or in case of the test with the pass/fail. Master Paper is also evaluated according to 10 grade scale.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree of Engineering Science in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering, or Bachelor Degree of Natural Sciences in Computer Science, Mathematics, Physics, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Intelligent Robotic Systems*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The title of the study program, the degree to be obtained, the stated aims, objectives, implementation methods, learning outcomes and admission requirements of the study program are mutually consistent and relevant. The study program is implemented in the form of full-time intramural studies in Latvian. In accordance with the pillar of academic excellence formulated in the RTU Strategy, the quality management of the study program is comprehensive and continuous, requiring changes in the curriculum, form of implementation or other aspects of the program in each academic year. During the reporting period, changes have been made through the introduction of new courses, the development of existing courses, changes of lecturers (for various reasons) or other actions related to the quality management of the program.

Nevertheless, the changes in the program parameters are related to the changes in the classification codes of the study programs in the country (Cabinet Regulations No 322 "Regulations on the classification of Latvian education " of 13 June 2017):

- During the previous accreditation period, study program code was 45481 - Information Technology, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science, with the degree “Master of Engineering in Computer Control and Computer Science”.
- Currently, the program code is 45526 - Other engineering sciences with the degree to be awarded “Master of Engineering Science in Intelligent Robotic Systems”.

The changes were implemented due to the fact that, according to the current classification, the field of Computer Science is currently partially included in the field of Computing (48), but the fields of Robotics and Artificial Intelligence, which are at the core of this study program, cannot be included in Computing (482 - Computer Applications, 483 - Computer Systems, Databases and Computer Networks, 484 - Programming). It is therefore necessary to change the code to the above in order to reflect as accurately as possible the nature and content of the study program.

In addition to the mentioned, changes have been made to the admission requirements to ensure compatibility between Bachelor study programs in the study field and this study program.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program is included in the study field “Information Technology, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science”, which comprises a range of study programs that focus on the application of technology and scientific knowledge specific to the field in the study process.

The title of the study program “Intelligent Robotic Systems” points at the synergy between two characteristic areas of modern science - Robotics and Artificial Intelligence, which is also manifested with regard to its curriculum, making the study program highly interdisciplinary. According to the current OECD classification of sectors, Artificial Intelligence is included in the field of natural sciences (Section 1), while Robotics is in the field of engineering (Section 2). According to the education sector classification used during the previous accreditation period, both fields correspond to engineering science (see Section 3.1.1 for details). The classification code of the currently foreseen program is 45526 - Other engineering sciences with the degree to be awarded “Master of Engineering Science in Intelligent Robotic Systems”.

The goal of the program is to train professionals with the ability to think systematically, analyze, design and implement technically and economically sound solutions for robotic and intelligent systems that contribute to the productivity and growth of the organizations that use them, as well as to develop students' ability to carry out scientific work, participate in local and international projects and pursue doctoral studies.

In accordance with the development trends of modern robotics, the mutual enrichment of the existing automation techniques and technologies with the achievements of the field of artificial intelligence play an increasingly important role, which allows switching to increasing autonomy systems in practically all areas of human activity. Therefore, although the program is interdisciplinary, its backbone consists of engineering study courses, which defines the program as belonging to the field of engineering as a whole. This is analyzed in more detail in section 3.2.1 “Content analysis of the study program”. It should be emphasized that, in addition to the compulsory courses, compulsory elective specialization study courses in the volume of 19CP all fall within the field of engineering.

The study program is implemented only in Latvian, as a full-time intramural study program in the volume of 80CP (2 study years). The study program is implemented in cooperation with three RTU faculties: the Faculty of Computer Science and Information Technology, the Faculty of Electrical and Environmental Engineering and the Faculty of Mechanical Engineering, Transport and Aeronautics. It is necessary because robotic systems are a combination of mechanics, electronics and software.

In order to ensure the necessary level of preparedness for studies at the academic Master study program “Intelligent Robotic Systems”, students should meet the following entry requirements:

Basic requirements:

Engineering Bachelor Degree in Computer Control and Computer Science, Intelligent Robotic Systems, Electrical Engineering, Mechanical Engineering or academic Bachelor degree in Mathematics, Physics or professional Bachelor degree in a field relevant to the aforementioned scientific disciplines, or compatible higher education.

Additional requirements:

In order to ensure the student's level of preparedness for the Master's degree program “Intelligent Robotic Systems”, the following study courses from the list below amounting to 8 CP must be completed:

One out of:

Study course	Volume in CP
Electrical Engineering and Electronics	2
Electrical Machines and Actuators	2
Linear and Nonlinear Systems	2
Random Processes	2
Methods of Systems Theory	2

One out of:

Study course	Volume in CP
Object-Oriented Programming	3
Algorithmization and Programming of Solutions	3
Intellectual Electrical Drive Systems	3

One out of:

Study course	Volume in CP
Fundamentals of Artificial Intelligence	3
Discrete Structures of Computer Science	3

If these study courses have not been taken before, they must be taken within 2 semesters from the start of the study program, choosing one course from each set. It can be seen that students are admitted to this program according to the level of their preparedness and relevance to the content of engineering studies.

It can therefore be argued that the title, classification, curriculum, admission requirements and actual implementation of the program are mutually consistent and fit well with the field of study.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

According to the study "World Robotics 2021 Industrial robots – executive summary" (Executive_Summary_WR_Industrial_Robots_2021.pdf (ifr.org)) on the market trends for industrial robots, it can be concluded that despite the effects of the pandemic, 2020 was the third best year ever, falling behind only 2017 and 2018. The most significant increase is observed in the electronics and automotive industries, which have historically been the most highly automated industries in the world. In total, in 2020, the largest ever number of installed robots was reached – approx. 3 million. Although the largest markets for robots are in Asia and the United States, European countries still maintain significant annual growth of 6%, which is faster than the overall economic growth of approx. 3%. This indicates structural changes in the economy and a gradual increase in efficiency in the future. This, in turn, will increasingly boost demand for engineers and service personnel in the relevant field. The growth trend is faster than the forecast at the time of the previous accreditation report, when an average of 4% growth was projected for the EU. ("Executive summary 1. World Robotics 2011 Industrial Robots"; data on industrial robots, quoted from: http://www.worldrobotics.org/uploads/media/2011_Executive_Summary.pdf).

Over the next decade, the number of industrial robot installations is expected to grow at an average annual rate of 8% in the EU countries and up to 17% in the Asian countries.

Latvia and the Baltic States as a whole will not be left out of this trend, as it is already evident that Latvian companies are investing much more in production automation and artificial intelligence applications in the wake of the pandemic crisis. Companies such as Ltd Robotic Solutions, Ltd Asya, SIA Giraffe, Ltd Playgineering, Ltd Winmill, Ltd RobotNest have emerged, demonstrating rapid development of the field in Latvia. Also, the well-known companies LMT, Accenture, TET, SAF Tehnika, Riga Smart IOT, etc. have focused on the development of various artificial intelligence, robotics and automation-based solutions.

This attests the need to train in the near future specialists with the skills to operate existing and develop new production automation systems, including robotic systems.

In the process of obtaining the license for the program, support was obtained from the Association of Mechanical Engineering and Metalworking Industries of Latvia, the Latvian IT Cluster, the Latvian Ministry of Defence and the Latvian Association of Computer Technologies.

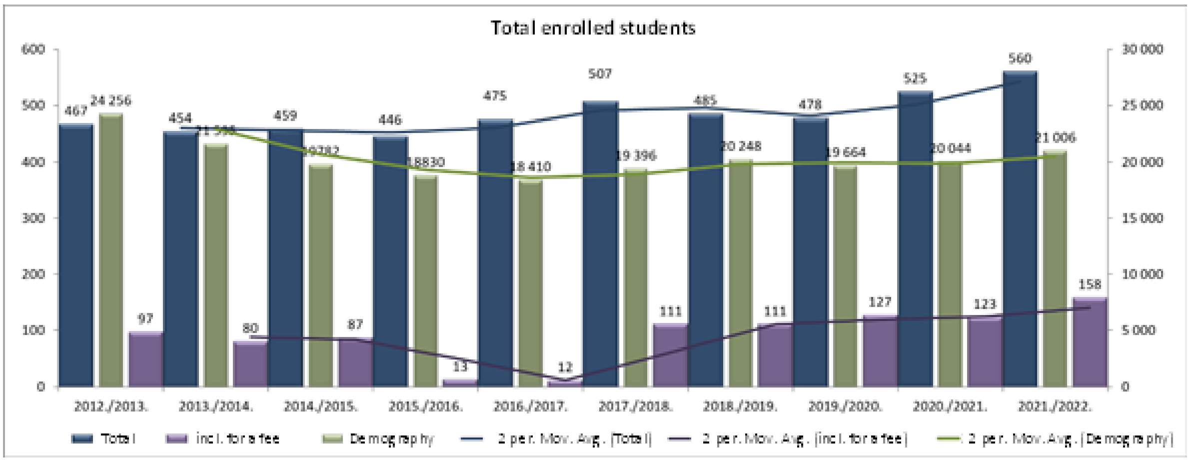
Currently, apart from the above-mentioned companies, which are the main providers of jobs for the program graduates (Ltd Asya and SIA Robotic Solutions, Ltd Playgineering, Ltd Giraffe are graduate-founded companies), automation companies such as ABB Latvija, Schneider, Peruza and others are active players in the labor market and jointly compete to attract study program graduates.

RTU is also a player in the labor market and annually recruits students and graduates for research projects, thus fostering professional development of the graduates and continuation of their research careers. According to the employment statistics of the graduates, all graduates are employed in the fields related to robotics or ICT. The increasing role of artificial intelligence in modern automation solutions, which requires highly skilled engineers with the right skill set, should be highlighted. The study program is the only one in Latvia that provides education in the necessary combination of robotics and AI to meet this growing demand.

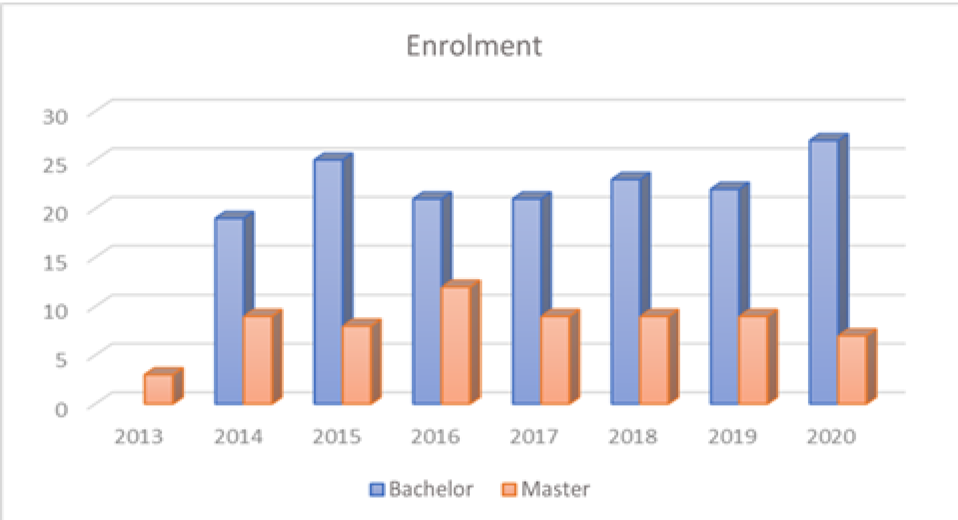
In general, RTU ranks 201st-250th according to the QS Graduate Employability Rankings 2020, which is considered to be a very good indicator in the global context as well.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

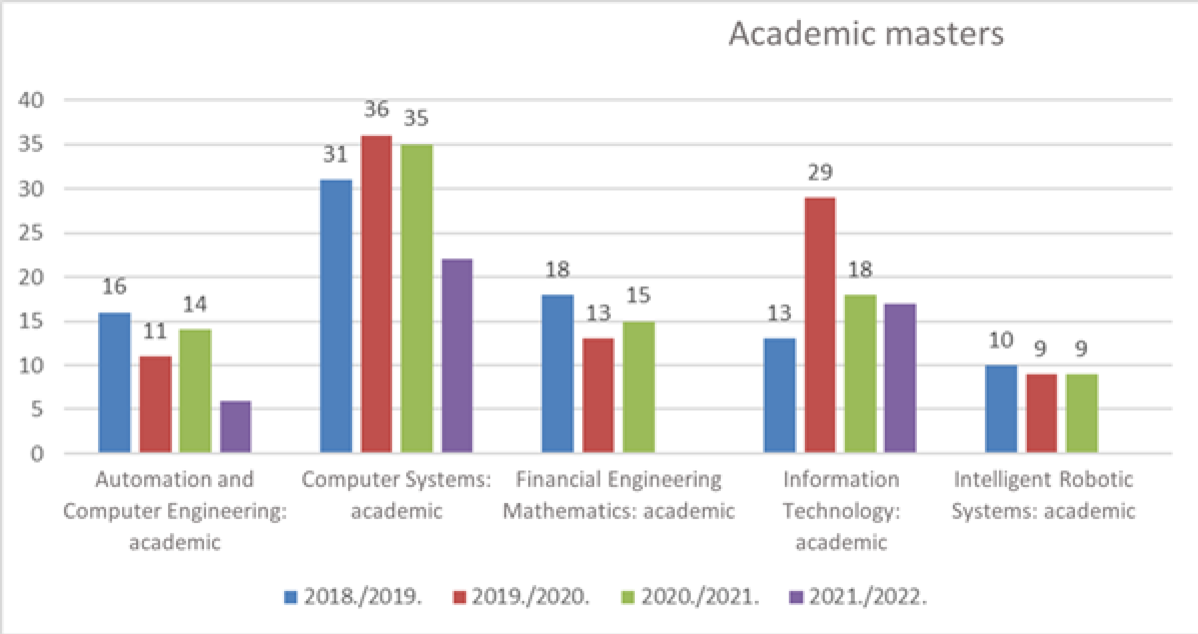
Student dynamics at the study program is strongly linked to the overall processes in the sector and to the demographic processes in Latvia as a whole. In the graph below, the total number of students enrolled in the Faculty of Computer Science and Information Technology can be observed in comparison with the demographic dynamics of Latvia (number of secondary school graduates available on the study market), as well as the demand for tuition fee funded study seats:



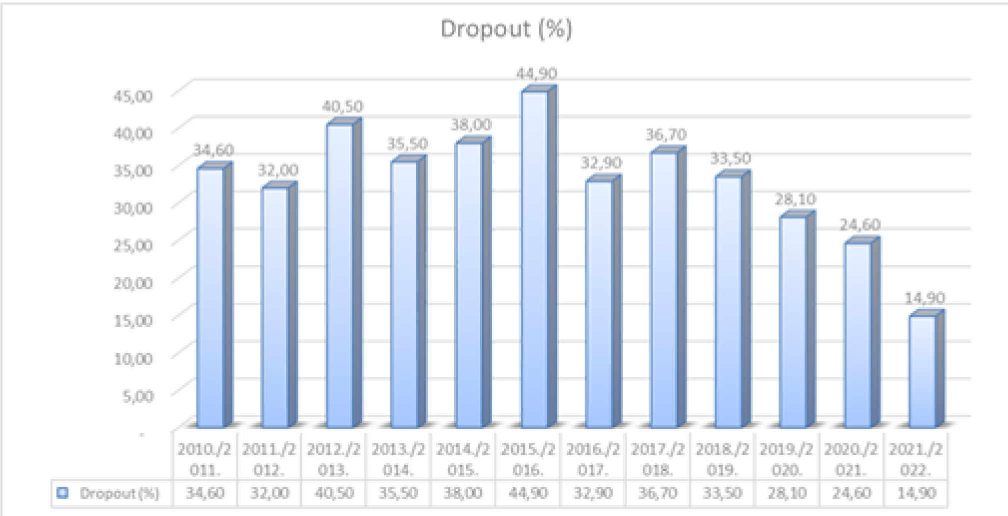
From the graph presenting the total number of enrolled Master students, it can be seen that in the field of the study program there is a positive trend in the growth of student numbers, both in terms of state budget funded and fee-paying students, which is very much in line with the overall development of the sector and trends in demand for specialists in the labor market. Although trends are observed in Masters studies, they persist also in Masters studies, but with a slight inertia effect, i.e., the results of a particular trend are observed with a lag of 2-3 years. It should be stressed that the overall trends are in line with the overall enrolment figures for Master studies in the faculty:



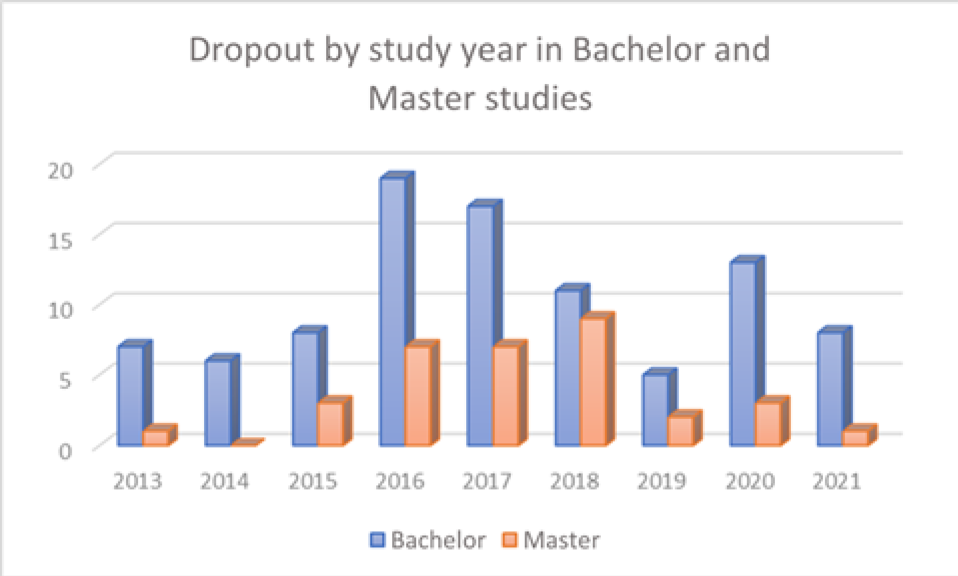
In general, it can be observed that the number of students enrolled in the study program is stable within the allocated state budget funded seats, which indicates a stable interest in the study program. In the context of other programs, over the last three years, the program has achieved stable enrolment figures, demonstrating a strong and sustained interest in the program and the field as a whole.



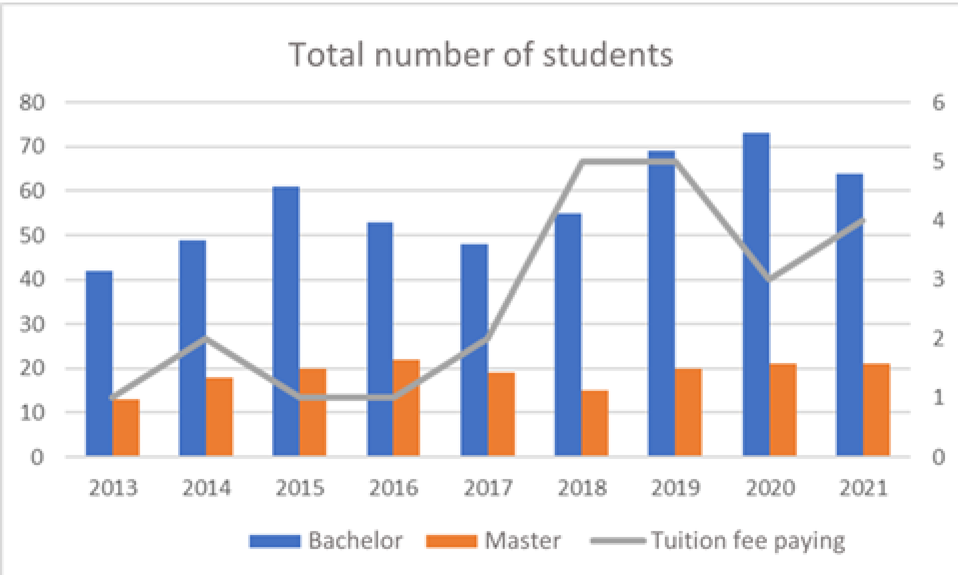
Given the niche nature of the study program, the sustained interest in the program suggests that its future development can be planned. Overall, the improvement in the dynamics of drop-out rates, which follows the overall trend at the faculty and largely reflects the positive impact of quality management measures on the overall trend, should also be highlighted:



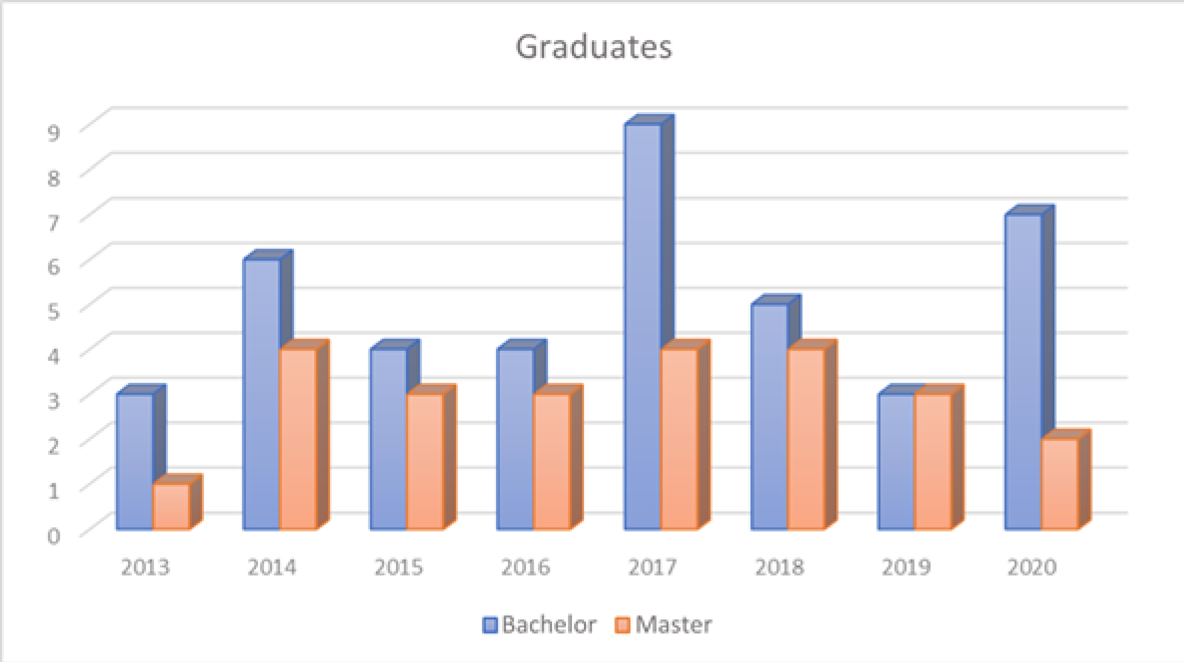
It can be observed that the exmatriculation dynamics (relative) is positive and is a result of the appropriate program management decisions. Specific dynamics in the program:



The study program is closely integrated with the Bachelor study program, which ensures an influx of students, so it is valuable to observe the trend also in relation to the trends at the Bachelor program. It can be seen that the dynamics of drop-out rates are generally positive also in the corresponding Bachelor program, which generally reflects sound program management measures for student retention. As a result of these decisions, an increase in the total number of students in the programs can also be observed. In addition, this trend continues in the Bachelor and fee-based programs, which have shown some, albeit modest, growth in recent years.



In terms of graduates, the study program somewhat suffers from the inertia of the measures taken, as shown in the graph below:



The alumni dynamics in general indicates the need to continue the positive changes in the program governance, which already has a positive impact on Bachelor program graduates (a clear increase in academic year 2020/2021), but due to the mentioned inertia in the Master program, changes are still expected.

In general, the study program holds a good overall position in terms of quality and demand among other programs, as well as demonstrates a number of positive trends reflecting the impact of management on student retention and the introduction of a more personalized approach to student motivation in daily work.

Statistical data on the Master study program “Intelligent Robotic Systems” are also presented in the Annex P05_3.1.4_DMR0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The aims, objectives, curriculum design and implementation methods of the study program are in line with the current trends in the industry, technology and sustainable management. The total volume of the study program is 80 CP, of which 37 CP are compulsory study courses and the rest are compulsory elective and free elective study courses.

- **Study courses of general education**

  Compulsory courses: Basics of Labour Protection, Research Methods and Technical Writing, Analog and Digital Signal Filters, Adaptive Systems in Industrial Electronics, Artificial Intelligence, Multiagent Systems, Autonomous systems and robots, Microprocessors - based Automation Systems, Sensors and sensor networks, Programming of Processes, Modern Production Technologies Basics, Industrial Process Automation (study project);

- **In-depth knowledge segments**

  This group of courses consists of compulsory elective study courses in the humanities and social sciences, pedagogy or economics and management, and free elective study courses.

- **Specialization study courses**

  This group is made up of compulsory elective study courses that allow you to choose between two specialisation areas:

  Hardware and control of robotic systems:

  - Adaptive Processing of the Signals;
  - Industrial Communication Network;
  - Embedded Systems;
  - Electro-Magnetic Compatibility in Industrial Electronic Equipment;
  - Industrial Electronic Equipment;
  - In Biological Systems Rooted Robots.

  Robotic system design:

  - Intelligent Robot Motion Planning;
  - Robot Modeling and Virtual Prototyping;
  - Scene Analysis and Computer Vision;
  - Data Mining;
  - Machine Learning;
  - Modern Robot Systems.

These thematic groups are not fixed modules of the study program. The subjects of the study program may be organized in several module systems to ensure flexibility in meeting the requirements of the labor market and, if needed, cooperation with similar study programs of universities in other countries.

Distribution of study courses by time and volume is given in the Table below:

Part	**Study course group**	**CP**	**(%)**
A	Compulsory study courses	37	46.25%

B	Compulsory elective study courses	19	23.75%
	1. Specialization study courses	15	18.75%
	2. Study courses in humanities, social sciences, pedagogy or economics and management	4	5.00%
C	Free elective study courses	4	5.00%
D	Master Thesis	20	25.00%
	Total	**80**	

The aim of the Master study program “Intelligent Robotic Systems” is to educate and train specialists with the ability to think systematically, analyze, develop and implement technically and economically sound solutions for robotic and intelligent systems that contribute to the productivity and growth of organizations using these solutions, as well as to develop students’ ability to conduct scientific work, participate in local and international projects and continue their studies at the PhD level.

In order to achieve the aim, several tasks of the study program have been defined, as well as the characteristics of their implementation. They are shown in the following table:

No	**Task**	**Performance indicators**
1.	To develop students’ systems thinking ability and practical skills that are necessary for development of the technically and economically reasoned robotic and intelligent system solutions;	The study program includes the study courses “Modern Robotic Systems”, “Autonomous Systems and Robots”, which promote application of systems approach principles in the design and development of robotic systems.
2.	To use in the study process both fundamental and classical solutions and the latest achievements in robotics and artificial intelligence; to promote students' individual and practical work, as well as direct communication and work in groups;	The study program includes several fundamental study courses in artificial intelligence and robotics, including “Artificial Intelligence”, “Process Programming”, “Analog and Digital Signal Filters”, etc. To account for the latest technologies and trends in robotics, the following courses are delivered: “Intelligent Robot Motion Planning”, “Robot Modeling and Virtual Prototyping”, “Multiagent Systems”, “In Biological Systems Rooted Robots” and orther. Many of these courses are completely new for Latvia and most EU countries. Machines, Industrial Electronic Equipment, Basics of Signal Theory, Electric Drive of Robots, Microprocessor Technology, etc. Independent and practical work is promoted through practical work within the study courses, as well as with the help of dedicated courses, for example, “Industrial Process Automation (study project)”

3.	To provide knowledge and experience provision for students in several areas by cooperation with teaching staff from different departments of RTU;	The study program is implemented in cooperation with three faculties: Faculty of Computer Science and Information Technology, Faculty of Electrical and Environmental Engineering, Faculty of Mechanical Engineering, Transport and Aeronautics. This ensures the provision of knowledge and experience in the relevant areas of the program to students. In addition to the above said, students are invited to choose topics for their graduation papers that focus on one of these areas.
4.	To assure the flexibility of the study program and the possibility to modify it in order to follow changes in the labor market and technology;	The study program includes both compulsory and elective study courses, and students can select a combination of the study courses, which allows them to adjust their curriculum according to own wishes and market requirements. Students have an additional opportunity to take advantage of the cooperation with the University of Tartu, which lets students increase the flexibility of the program and its capacity to adapt to specific changes in the labor market, industry, or student demand.
5.	To ensure achievement of the learning outcomes defined for the program listed below;	The following learning outcomes of the study program are achieved by combining the knowledge and skills obtained within the compulsory and elective study courses with the practice gained during laboratory works and projects, as well as by developing research skills in the graduation paper development process. Thus, the combination of the learning outcomes of separate study courses ensures the fulfillment of the common aims and tasks of the study program.
6.	To develop cooperation with similar or thematically related programs in other countries within ERASMUS and other agreements;	An ERASMUS cooperation agreement has been signed with the University of Tartu (attached as an additional appendix). Such ERASMUS + study development projects as IOT.OPEN.EU and Autonomian have been implemented, which have allowed supplementing the curriculum and include definite thematic blocks for content improvement in the study courses.
7.	To stimulate in students desire to participate in implementation of scientific research;	The study course “Research Methods and Technical Writing” and the graduation paper are the most important means for attracting students to research. The Master Thesis is developed as a research paper in close cooperation with the supervisor, paying special attention to a specific field of research, which is chosen by the student. Thus, the interest and initiative of the student's scientific research is specifically supported.

8.	To prepare and motivate students for their Doctoral studies.	The study program includes the course Research Methods and Technical Writing", which acquaints the students with the scientific research methods, presentation of research results, formulation of research goals. The Master Thesis is developed as a research project. RTU Master study grants are available to the Master students - financial support for the development of research within the Master Thesis. Students are also actively involved in research projects, e.g., H2020 ECSEL CHARM project, where PhD and Master students make a significant contribution. LIAA commercialization projects resulting in the establishment of new companies and design of new technologies are a good example of both research activities and innovation and technology transfer implemented by the students of the program. Thus, conducting research during Master studies is stimulated in the topical research fields and Master students are encouraged to continue their studies at the PhD programs.

According to the mapping of the leaning outcomes of the study program, it can be concluded that all study aims are achieved. Due to the rapid change in the field, changes have been introduced in the program during the accreditation period, which affect both general and specific study courses.

Several continuous quality assurance and management activities are carried out to update study courses according to the needs of the industry. They include the active participation of industry representatives in all meetings of the Study Direction Commission, which ensures that the discussed issues are adjusted to the needs of the industry, as well as receiving new proposals from industry representatives. In addition to the above, the involvement of industry teaching staff in the implementation of specific study courses is carried out, which allows not only the actualization of specific topics, but also allows maintaining a sufficiently intensive dialogue with specific companies of the industry about the needs of the industry. The director of the study program is a member of the board of LIKTA, the industry's largest association, which allows us to obtain the needs of the industry and influence the development of the industry at the same time, thus contributing to the achievement of the goals of the study program and the field of study.

The major changes concern the use of course curriculum and teaching methods within specific courses.

- The set of available equipment has been expanded to allow the development of kinematic models and control software for specific robots within such courses as Robot Modelling and Virtual Prototyping (DDI700). The equipment set has been extended to include Baxter, ABB 1200, Aldebaran / Softbank Robotics Pepper, Jaguar and others from the Robot Prototyping Laboratory for the development of control and sensor systems.
- The course in Machine Learning introduces a broader range of up-to-date algorithms and methods, reinforced by relevant practical work on the online collaboration platforms Google Colab and Jupyter Notebooks Server.
- An additional course in advanced machine learning, Introduction to Deep Machine Learning (DSP793), has been introduced and is available to students in the free elective study course block, while a new course, Introduction to High Performance Computing Technology CUDA

(DMI741), has been added to the compulsory elective study course block, providing practical experience in the application of modern technologies in the context of artificial intelligence or other fields.

A specific and distinctive feature of the study program is the course blocks in the field of artificial intelligence and autonomy, which make the program highly relevant to the current trends. Comparatively, in the first phase of accreditation (starting in 2012), the program has evolved from a future-oriented to a presently topical study program, which is much more conducive for attracting students. This attests that the program is in line with both public perception of technological developments and industry trends.

One of the achievements is the successful establishment of companies in the field of artificial intelligence and robotics by graduates of the study program - Ltd Asya and Ltd RoboticSolutions, which have worked in the technology market and technology development for several years.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The degree to be awarded is the Master Degree of Engineering Science in Intelligent Robotic Systems. As mentioned in 3.1.3, modern developments are leading to the increasing use of artificial intelligence and production automation technologies in everyday production and economic processes. This also determines the vision of the study program regarding the potential employment and possible specializations of its graduates.

The study program envisions two areas of specialization - Robotic Systems Design and Robotic Systems Hardware, both provide relatively extensive content in the field of artificial intelligence, including the following core courses: DSP422 "Artificial Intelligence", DSP714 "Intelligent Robot Motion Planning", DSP715 "Autonomous Systems and Robots", DSP713 "Machine Learning".

Given the advent of advanced artificial intelligence techniques, such as deep machine learning, in the modern industry and modern automation solutions, the study program pays special attention to the relevant themes with the course DSP793 "Introduction to Deep Machine Learning", DSP801 "Deep Machine Learning of Metrics" and DMI741 "Introduction to High Performance Computing Technology CUDA", which together provide both theoretical knowledge of specific techniques and the skills to apply them in practice for the development of prototypes and embedded systems.

The lecturers of these and other courses mainly carry out their research in the relevant fields of science. Below are the SCOPUS metrics in the scientific publications database:

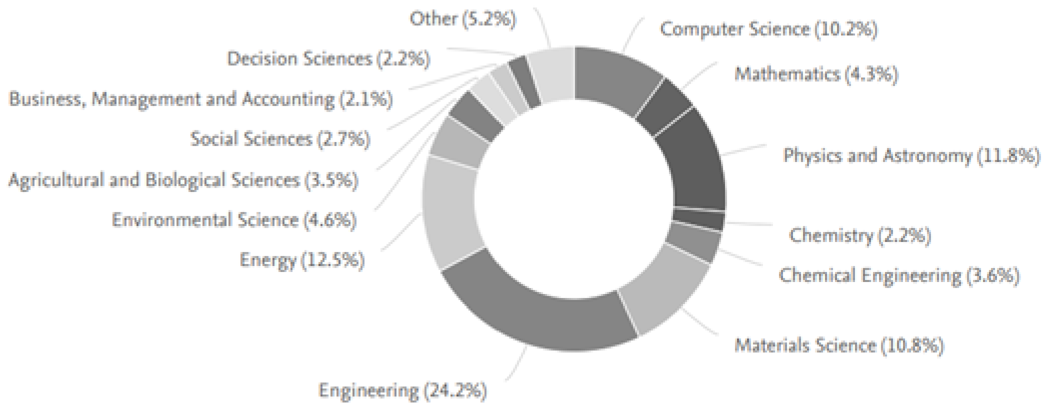


Figure: RTU academic contribution by field of science, SCOPUS, January 2022.

Some of the most important contributions are in engineering and computer science:

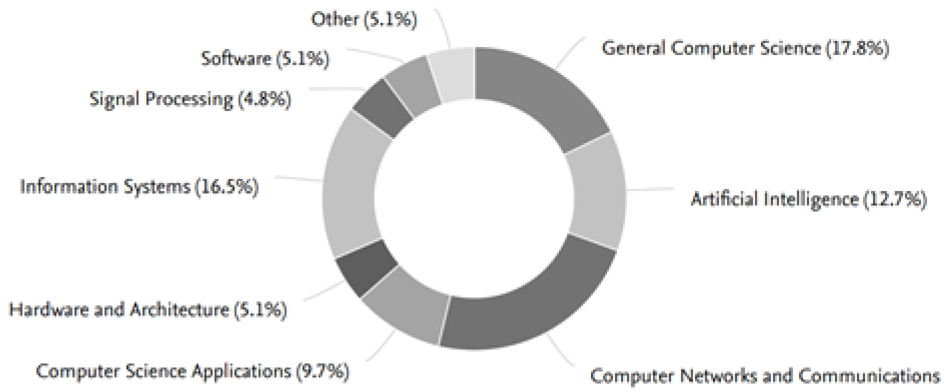


Figure: RTU Contributions to Computer Science, SCOPUS, January 2022

It can be clearly observed that Artificial Intelligence makes a significant part of the total contribution in the field of computer science, indicating the relevance of the research of the staff involved in program implementation to the aims and tasks of the study program and to the relevant field as a whole. Focusing specifically on Artificial Intelligence, it can be observed that the study program is in line with the most relevant current research areas:

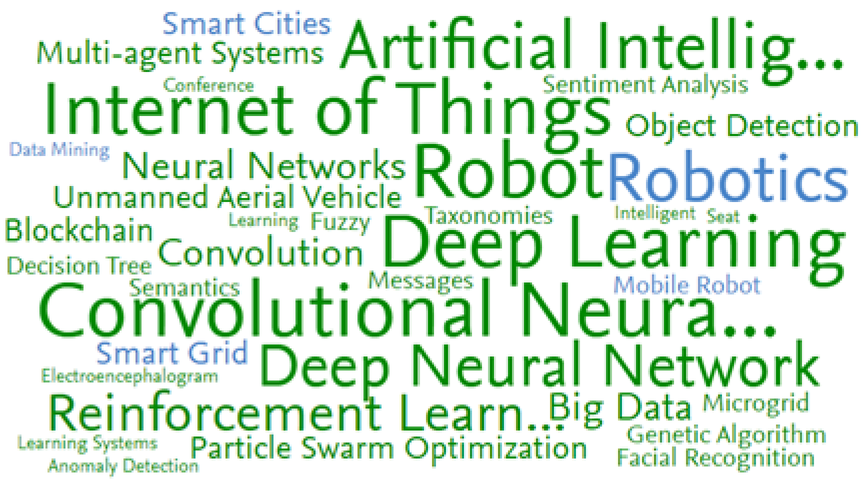


Figure: The keywords of the world's 272K publications on Artificial Intelligence, SCOPUS, in January 2022 for publications in the period 2018 – 2020.

It should be stressed that even the name of the program is in line with these trends, and the changes and additions made during the accreditation period are fully in line with the developments in the relevant research fields. It can thus be stated that the curriculum of the study program, the academic staff involved in its implementation and the nature of the changes made are fully in line with the trends and needs of the relevant fields of science and industry.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

According to the aims and tasks of the study program, study courses are implemented in different volumes according to the study plan - 1 - 4 or more CP. To implement the study plan, fundamental engineering courses may exceed 4CP, thus emphasizing the importance of specific fields in engineering. For example, mathematics and physics are allocated a relatively higher volume than the courses specializing in a particular field. The specialized courses in the program area amount to 3 or 4CP, which allows both developing the theoretical knowledge and devoting sufficient time to the acquisition of practical skills and to independent work. It should be stressed that most courses of more than 2CP also include practical work or group work.

This approach to structuring the program and focusing on specific areas is in line with the existing good practice in Latvia and beyond.

In addition to the lectures or practical classes, a certain amount of CP is provided for group work or independent work (at home or in the laboratory). It should be stressed that the program is particularly proud of its access to the Robotic Prototyping Laboratory, which provides students with experience in prototyping and application of appropriate methods for design and development of robotic systems already in the first semester. It is the course EEI502 “Industrial Process Automation (study project)”. These courses greatly enhance the study program by allowing students to gain experience in all phases of robotic system development within a single project, thus preparing them for the job market.

Group work is supported by a number of courses, the aforementioned EEI502 “Industrial Process Automation (study project)”, DSP715 “Autonomous Systems and Robots”, as well as other courses to a lesser extent. Student collaboration within a group, as well as performance of specific roles during the simulation of a design project, provides insights into the implementation of industry-specific design processes, and helps gain experience in the development and implementation of an integrated communication system.

In order to facilitate student collaboration and the development of independent problem-solving skills, students are offered a wide range of equipment and infrastructure - laboratories, virtual solutions (virtual computers, HPC, etc.), unified RTU software services (MS Teams, Office 365, Solidworks, etc.), prototyping equipment (CNC, laser cutting equipment, SMD assembly equipment, LabView Instrumentation, IOT laboratory, meeting rooms and equipment, as well as other specific equipment. In addition to the above-mentioned, course EEI502 “Industrial Process Automation (study project)”, offers groups of students a budget for the purchase or rental of equipment, parts and facilities, which allows projects to be developed independently of existing equipment, if necessary. The budget is mainly provided from the financing of the implementation of industrial projects.

To encourage student involvement in further studies and to provide research experience, the study program also offers part-time work in specific practical research projects. At the time of writing the report, students are involved in the following projects: the H2020 ECSEL CHARM project, iDārzs, several innovation voucher projects by the Investment and Development Agency of Latvia (LIAA) and, during the accreditation period, new product development projects of LIAA.

In the framework of such courses as DSP722 “Multiagent Systems”, EEI357 “Analog and Digital Signal Filters”, MTM406 “In Biological Systems Rooted Robots”, as well as in the practical parts of courses of general education, modelling software systems Matlab with Simulink, ABB Robot Studio, Solidworks, Mathcad, Mathematica, etc. are used, which also allows developing virtual system design skills according to the requirements of contemporary industry.

In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific undergraduate paper research, the choice of a particular major, as well as in group work, which to a large extent also allows manifestation of organizational skills, leadership qualities and other transdisciplinary skills. In several courses, such as DSP713 “Machine Learning” or DSP801 “Deep metric learning”, the course material is supplemented with e-content, which allows students to choose the form of learning according to their perceptual characteristics. These materials can be combined with traditional lecture-oriented content to complement their skills and knowledge.

In order to enable effective use of the study materials for practical and independent work, RTU uses the ORTUS e-learning environment, additional communication opportunities provided by this system as well. Self-testing (automated test options) and interactivity are used in several courses as part of the study process. For example, several lecturers - A.Ņikitenko, A.Anohina-Naumeca, K. Boločko, etc. - widely use such tool as Mentimeter (Interactive presentation software - Mentimeter), which allows getting feedback on the dynamics of learning the material and student experience.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

In the reporting period, approximately ~25 young professionals have graduated from the study program, having fulfilled the program requirements and developed a graduation paper.

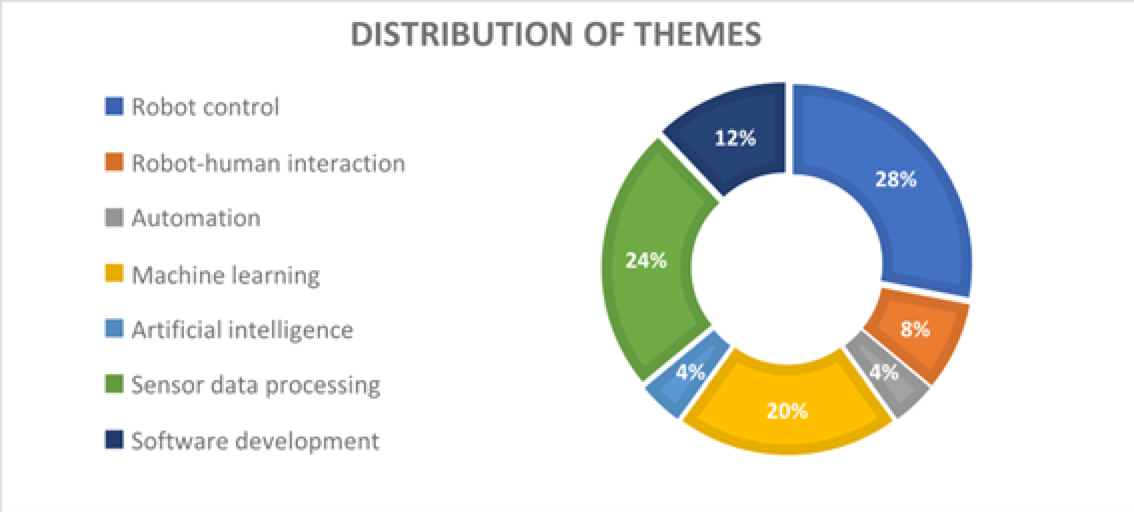
The thematic groups are divided according to historical experience and industry best practice, which envisions distinguishing between automation solutions, which are more oriented towards manufacturing processes, and other robot control problems, such as intelligent control, or multi-robot systems in general. It also separates generic or combined AI solutions from machine learning, which is in line with current AI trends. Given that the thematic groups may also cover applications of AI in software solutions not directly related to robotic systems, the topics of these groups are also categorized for analysis.

The themes of the graduation papers can therefore be grouped as follows:

- Robot control - controlling the hardware and movements of robots to perform different tasks.
- Robot-human interaction - themes are largely related to communication issues, which are essential in modern robotics;
- Automation - themes in this group are related to solving problems of automation of various manufacturing processes;
- Machine learning - themes in this group focus on applications of deep machine learning technology in robotics or AI in general;
- Artificial intelligence - themes in this group relate to artificial intelligence techniques that may not be directly related to robotic systems or machine learning.
- Sensor data processing - themes focusing on sensor data processing issues such as filtering, fusion or the use of new types of sensors, as well as methods that integrate with other methods or techniques.
- Software development - a range of themes that focus on software engineering issues and may not be directly related to robotic systems.

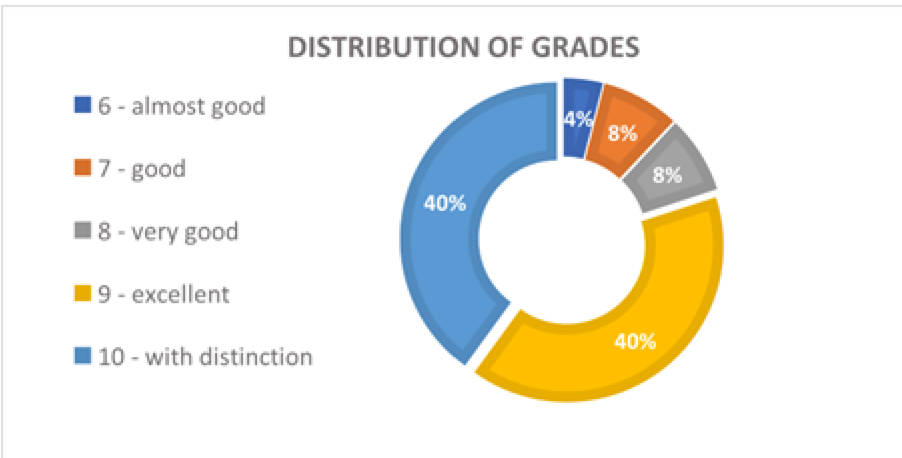
The relative distribution of themes according to this classification is shown below. As it can be seen, the distribution of themes is in line with the fields of specialization of the study program, focusing on those topics that are relevant to robot control and artificial intelligence.

It should be emphasized that the most researched topics are Robotic Controls (28%), Sensor Data Processing (24%) and Machine Learning (20%), which indicates the relevance of the research to the current trends in robotics as well as to the current research areas of the faculty. Thus, it can be noticed that the research themes are in line with current scientific and industry trends.



Looking at 50 key terms in the topic titles (see below), the topic titles are also relevant to the specialization of the study program, emphasizing mobile robotic systems, deep machine learning, sensor analysis and other themes mentioned above.

The results of analysis of the graduation paper grades are presented in the following figure:

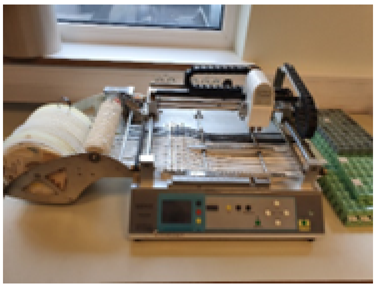


It can be seen that more than a half of the graduates have obtained an assessment “excellent” and “with distinction”. The evaluation is carried out by a committee, which traditionally includes not only the instructors implementing the program, but also representatives of other RTU departments, as well as the Latvian University of Agriculture, which improves the quality of the committee's work. This composition of the committee is part of the continuous quality assurance approach to ensure the most objective evaluation and a multifaceted view of the results achieved in the graduation papers. Thus, graduation paper grades attest a relatively high quality of the graduation papers.

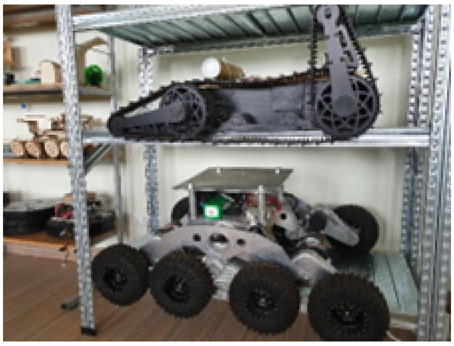
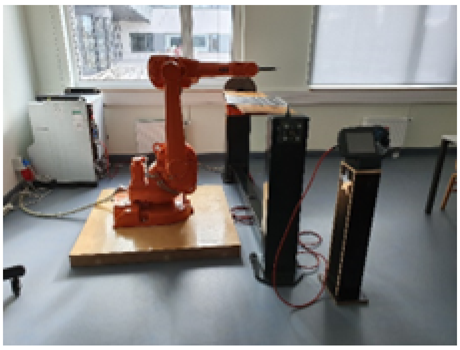
3.3. Resources and Provision of the Study Programme

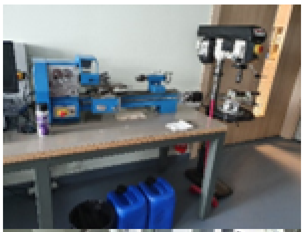
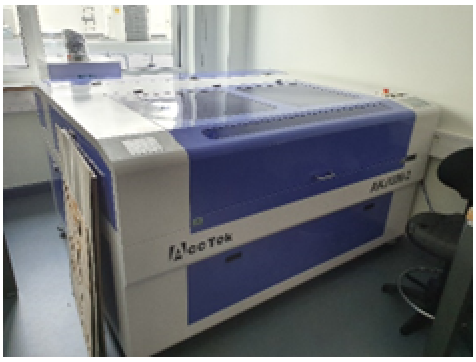
3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

During program implementation period, significant investments have been made to supplement the material and technical resource base for the implementation of the study program both for the provision of studies and for scientific and applied research. All available resources can be divided into centralized resources, such as subscriptions maintained by the RTU Scientific Library and electronic repositories, and study program-specific resources that complement the centralized resources. The centralized resources are described in detail in the relevant sections of the Study Field Resources. Specific equipment is described in detail below:

Image	Description	Use
	SMD assembly line. The line is designed for the production of small electronic circuits. The line includes an assembly robot, a solder paste application machine and a soldering thermal chamber. As part of the study program, it is used for the production of sensors for teaching robot systems, as well as for the production or prototyping within students' graduation papers.	Studies Research

	3D printers. In addition to the RTU Design Factory, the Robotic Prototyping Lab of the Faculty of Computer Science and Information Technology offers access to 3D printers for prototyping. The printers, together with appropriate software available to all RTU students (Solidworks, CURA, etc.), are used in the courses "Introduction to Study Field" and "Robot Control System Development Project".	Studies Research
	Robot Baxter. Provides two synchronized manipulators working together, augmented with different types of sensors and tools (pneumatic grippers, electric grippers, etc.). The robot is used for various demonstration projects and for training students in the basics of industrial robot control. The robot was part of the research project RobotCom++.	Studies Research
	Robot Pepper. Used for student projects and demonstration purposes. Actively used within the course “Robot Control System Development Project”, where students develop Robot-Human Interface projects, thus learning more complex development environments and corresponding applications.	Studies Research

	A prototyping room that serves as a testing ground for various projects. The images show materials available to students and researchers, as well as equipment and robots actively used in industrial developments.	Studies Research
	Prototyping platforms. The platforms are mainly used for students' graduation papers, as well as for the course “Robot Control System Development Project” helping them learn the control features of different platforms.	Studies Research
	ABB IRB 1200. An industrial robot used mainly in the context of studies to provide hands-on experience within industrial robot control courses. The robot has also been used in the RoboCom++ project as part of a demonstration production line.	Studies Research
	ABB IRB 1600 An industrial robot used mainly in the context of studies to provide hands-on experience in industrial robot control courses. The robot is actively used for various student designs and demonstrations. The robot is part of a robot programming teaching laboratory which is used to provide students with skills and knowledge in robot modelling and programming.	Studies

  	CNC equipment CNC equipment is used for student projects and graduation papers. Given that the use of the equipment can involve specific knowledge and skills, HAAS CNC equipment is only used with the assistance of an experienced engineer, and the simplest equipment with appropriate instruction.	Studies Research
	Laser cutting equipment The equipment is a relatively recent acquisition (shortly before the report was written) and has not yet been integrated into the study process, but it is being used for development of various prototype equipment. The equipment is only used by experienced engineers who have been appropriately trained.	Research
	Measuring equipment and reference materials. For the purpose of the study program, large stock of measuring equipment (oscilloscopes, digital signal analyzers, radio signal analyzers, multimeters, and other specific measuring equipment), hand-held instruments are available. This equipment is complemented by RPi, ESP32, Arduino and other microcomputers available for study and development purposes.	Studies Research

	Robotics kits Designed for development purposes and for learning the basics of electronics and programming mobile robots. The kits are complemented by electronic learning material that can also be used for distance learning.	Studies

As mentioned above, specific equipment is also used for study purposes and is available centrally as well as at other faculties. The Faculty of Electrical and Environmental Engineering is the most important contributor, providing the necessary measuring equipment and visual learning aids for the study process, in particular Siemens industrial automation laboratory, motor control equipment, etc. Thus, it can be argued that the equipment and resources available for studies are relatively abundant and sufficient also for students' activities outside studies.

A detailed description of the infrastructure and material-technical base, as well as methodological and informational provision, is given in Chapter 3 of Part II of the course description "Resources and provision of the study course", where subsection 2.3.2 is devoted to the description of the infrastructure and material-technical provision, while 2.3.3 is given a detailed reflection of methodological and information provision (including the range of options offered by the RTU scientific library). Subchapter 2.3.4 is devoted to the description of the information and communication technology solutions used.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

According to the RTU regulations, study programs are financed mainly from state budget funds and tuition fees, which are used for staff remuneration, infrastructure development and other essential aspects. Formally, RTU revenues and expenditures are managed according to the principles approved by the Senate, or by the Vice-Rector of Finance with the authority granted to him.

Revenue is allocated to the organizational unit in accordance with the needs and regulations of the program for the execution of specific work for which it is responsible, i.e., implementation of specific courses, provision of tutorials based on the planned volume of work and/or indicators reported in previous periods (e.g., scientific support). RTU provides each Head of Organizational Unit with remote access to operational financial information on the Organizational Unit's budget, including the planned workload and the corresponding funding to be allocated in future periods for the implementation of study programs and study courses.

Heads of Organizational Units are responsible for the use of the funds at the Organizational Unit's disposal in accordance with the plans developed at the beginning of each budget year through access to the RTU financial management information system.

Currently, state budget funded seats at the study program "Intelligent Robotic Systems" are fully filled and there is a stable competition for admission, which attests the quality and financial self-sufficiency of the study program. The main sources of funding for the program by year are listed in the table below:

Academic year	State subsidy, EUR	Local student tuition fees, EUR	Total study program funding, EUR	Funding of one state budget funded seat, EUR
2013/2014	36982.00		36982.00	5799.00
2014/2015	38543.62		38543.62	5799.03
2015/2016	43310.12		43310.12	5799.03
2016/2017	40632.15		40632.15	5799.03
2017/2018	64669.20		64669.20	6060.99
2018/2019	51525.27		51525.27	6344.52
2019/2020	47287.20	1750.00	49037.20	6607.56
2020/2021	38155.83		38155.83	6694.22

Detailed information on the distribution of funding between cost items is provided in the appendix to the self-assessment report "Distribution of funding between cost items". Information on the minimum required number of students in the program is given in the appendix to the self-evaluation report "On_minimum_number_of students_in_the_study_programs".

The drop in the received revenue in academic year 2019/ 2020 may be explained by the consequences of Covid-19 pandemic, when the signal that students prefer intramural studies over remote ones was received.

Given the active involvement of the staff, the participation in various externally funded research and development projects, the involvement of teachers in several programs at the same time, and the judicious and far-sighted use of study funds, it can be said that overall funding is sufficient and allows for further development.

The available funding is mainly used to pay the work of teaching staff, as well as to maintain and improve the teaching infrastructure. The implementing structural unit – the Department of Artificial Intelligence and Systems Engineering, in the person of its head and the director of the study program, is responsible for specific financing tasks. Funding decisions are made at the department, institute or faculty level, depending on the specific event. Significant efforts are devoted to enriching the skills and abilities of teaching staff, therefore part of the funding is devoted to paying for various courses, seminars, business trips, as well as academic vacations. Also, an investment is systematically planned for the addition of ICT equipment, specifically for the provision of virtualizable computing resources, which are necessary for the operation of computer classes and the implementation of research processes. The implementation of the mentioned activities in accordance with other significant investments in the infrastructure and the improvement of the curriculum provides a synergistic effect for the development of the study program as a whole.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff implementing the study program fully correspond to the specifics of the study program and the requirements of the regulatory enactments. The interdisciplinary nature of the study program requires attraction of highly qualified specialists, specializing in specific thematic areas of study courses, providing their experience in relevant business areas or offering a combination thereof, thus ensuring excellence of the academic performance of the program. Below is information about the leading members of academic staff involved in the implementation of the program.

Dr.sc.ing. Agris Ņikitenko is a Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). He is the author of more than 35 scientific publications, several textbooks and patents. He has co-founded several companies, including RoboticSolutions Ltd. and RobotNest Ltd., and actively participates in the strengthening and development of the Latvian ICT ecosystem. He has been the Head of the study program “Intelligent Robotic Systems” since its inception and is the initiator of the program. Currently, he is a member of the Latvian Information and Communications Technology Association (LIKTA) Board, LEO Competence Centre Board, RTU Robotics Club Board, and is active in various expert discussions and platforms. He is an active expert at the Latvian Council of Science (LCS) and part-time Associate Professor at the Norwegian University of Science and Technology (NTNU) since 2021.

Dr.habil.sc.ing. Jānis Grundspeņķis is a Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). He has actually established the FCSIT School of Artificial Intelligence and has ensured defense of more than 13 PhD Theses in this field. He is the author of at least 110 publications, sole author of many textbooks and co-author of other academic publications. He is an active principal investigator in scientific research projects, as well as the leader and implementer of collaborative projects. He is the Head of the Doctoral Council P-07, as well as an expert of the LCS and chair of the Expert Committee in Computer Science. He is the architect and the head of the faculty's most sought-after study program “Computer Systems” since its launch until 2019. Under his leadership, a quality management system for the study environment at FCSIT and a work culture among the faculty team have been established, which jointly ensure effective management and implementation of the study programs.

Dr.habil.sc.ing. Leonīds Ribickis is an Academician of the Latvian Academy of Sciences, Rector and Professor at RTU. He is a member of several Latvian and international organizations, including the Senate of the LAS (until 2020), a member of the Board of the Association of Latvian Universities (until 2019), a member of the Network of Rectors and Deans of Nordic Technical Universities, a member of the IEEE Worldwide Institute of Electrical and Electronics Engineers and the Head of the Latvian Section, a co-author of at least 30 Latvian and international patents (about 40 USSR patents), co-author of more than 600 scientific publications, including 21 monographs. Under the scientific supervision of Leonīds Ribickis, 13 PhD Theses have been publicly presented. He is among the leading experts in electrical engineering, energy and power electronics at RTU, who shares his expertise with students and faculty in at least 10 study courses.

Dr.sc.ing. Alla Anohina-Naumeca is an Associate Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). In 2015, she received a Doctor of Education degree from the University of Latvia. She is one of the most recognized faculty members by students, contributing to the goals of academic excellence at FCSIT also in the position of the Deputy Dean for Academic Affairs since 2018. She is an active expert at the LAS and part-time professor at the Norwegian University of Science and Technology (NTNU) since 2021. She is an active contributor to the academic integrity policy at FCSIT and RTU. In 2020 and 2021, she honed her academic skills at the University at Buffalo (USA) in order to improve the study process and move towards increasingly high-quality studies. She is an active participant in scientific research projects as well as a creator of Massive Open Online Courses (MOOCs) at RTU.

Dr.sc.ing. Egons Lavendelis is an Associate Professor of the Faculty of Computer Science and Information Technology (FCSIT), Riga Technical University (RTU). Author of more than 35 scientific publications and the leader or executor of several scientific research projects. Since 2019, he is the Head of the RTU Institute of Applied Computer Systems and the Head of the study program "Computer Systems", ensuring excellence of the study program and the Institute. He is the responsible instructor at several courses, including "Multi-Agent Systems", which is one of the best appreciated courses in the study program. Since 2017, he is the Head of the RTU Sports Centre and has been responsible for the reform of the Sports Centre at RTU. He is actively involved in strengthening academic excellence and is the author of many initiatives, including the activities aimed at strengthening of the quality of study programs and promotion of the principles of academic integrity.

Dr.oec., Elīna Gaile-Sarkane is a Professor of the Faculty of Engineering Economics and Management (FEEM), Riga Technical University (RTU). E. Gaile-Sarkane has authored more than 140 scientific publications since 2000 and has more than 20 years of research experience. Many papers have been published in internationally recognized journals or conference proceedings indexed in international databases (e.g., Thomson and Reuter, Scopus, EBSCO, etc.). Co-author of two patents, both developed within the framework of the study program "Innovation and Entrepreneurship". Prof. Elīna Gaile-Sarkane is a member of RTU Doctoral Board P-09, expert of LCS, expert of the Czech Grant Agency, member of many international organizations, member of the Joint Professorial Council of Riga School of International Economics and Business Administration, School of Banking and Ventspils University College in the field of Management and Economics. Prof. Gaile-Sarkane's research interests are highly interdisciplinary, covering management, innovation management, technology transfer and various aspects of entrepreneurship.

It should be emphasized that in addition to the senior academic staff, other academically excellent and active colleagues contribute to the study program, ensuring its high quality, development and day-to-day achievement of the program's objectives. Detailed curriculum vitae of academic staff can be found in the relevant annexes.

During the accreditation period, active work has been carried out on professional development and mobility activities, which have involved attracting guest lecturers from Latvia and abroad. A summary of such guest lectures is given in the following table:

The following guest lecturers worked at the program within **SAM8.2.2. project:**

Stojmenovic Milos (Serbia, Canada), As part of the visit, a new study course DSP793 "Introduction to Deep Machine Learning" was created, which is now available at the study program "Intelligent Robotic Systems" as well as at other study programs.	01.02.2020.	31.07.2020.
Czekalski Piotr Boleslaw (Poland), As part of the visit, a new study course DSP791 "Introduction to Internet of Things Technologies and Applications" was created, which is now available at the study program "Intelligent Robotic Systems" as well as at other study programs.	21.02.2020.	20.08.2020.

In cooperation with **IEEE Latvia Section**, the following guest lectures were held for students and staff of the faculty:

- 06.06.2016. Embedded Systems as Foundations of Cyber-Physical Systems, Bernadetta Kwintiana Ane, IEEE Distinguished Visitors Program;
- 25.10.2017. Big Data Science as a Service, Sherif Sakr, IEEE Distinguished Visitors Program;
- 26.11.2018. 2020: Toward Practical Quantum Computing, Marcello Caleffi, IEEE Distinguished Visitors Program.

Guest lectures delivered by the companies:

- 03.12.2019. How to Create Effective Solutions for Business: Approach and Technologies, guest lecture by "Consolware";
- 12.02.2019. Computer Vision, Robots, Cobots – who will solve difficult tasks in the near future? guest lecture by "Peruza".

Faculty organized seminars, providing the forum for discussion of topical issues related to the implementation of the study process and experience exchange:

- 20.02.2019. Academic Integrity and Work with the Foreign Students;
- 18.12.2020. Organization of Exam in the Remote Mode;
- 12.02.2021. Implementing Studies in the Remote Mode;
- 12.03.2021. Student of the Digital Age (Zanda Rubene, UL professor);
- 28.01.2022. Academic Integrity at RTU and FCSIT;
- 25.02.2022. Formative assessment: with and without technology (Anžela Jurāne-Brēmane, ViA researcher).

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The total number of academic staff as well as the distribution of qualifications did not change significantly during the reporting period, with 9 professors, 6 associate professors and 1 assistant professor being involved in program implementation. All involved academic staff holding a PhD degree have Riga Technical University as their main employer. Changes in the number of academic staff within specific courses are related to the continuous quality management within the study program.

In the context of quality management of a study program, the replacement of an academic staff member may be attributed to several factors:

- Replacing a study course with another, thus excluding a particular member of the academic staff from working with students;
- A change in the curriculum of a study course requiring a change in the composition of the academic staff;
- Quality assurance measures for a study course requiring the replacement of a specific member of the academic staff by another member in the same field;
- Voluntary changes in the working relationship of an academic staff member, which may involve a change in the volume or structure of the workload within a specific study program.

Quality assurance of program implementation is a key responsibility of the head of the study program, which requires that reports or incidents compromising the quality of a particular program be investigated and responded to through negotiation, deeper analysis or, in cases of extreme necessity, replacement of a member of the academic staff with another member in the relevant field.

The decision to change the academic staff in this case may be made at the level of the management of the organizational unit responsible for the study course, as a reaction to poor quality work, or as a consequence of the decision of the Study Field Committee to replace a member of the academic staff. Given the relatively high culture of internal communication between RTU and FCSIT, the Study Field Committee has not faced any issues of this nature during the reporting period.

Changes at the level of organizational unit have taken place in the following courses:

- **DSP722 “Multiagent Systems”**. The change of lecturer was made due to a voluntary change in the lecturer's workload and “transfer” of the course to younger colleagues. Significant changes in the delivery methodology or student feedback could not be observed.
- **DSP722 “Embedded Systems”**. The change of lecturer was made due to a voluntary change in the lecturer’s workload and “transfer” of the course to younger colleagues. Significant changes in the delivery methodology or student feedback could not be observed.
- **DAA422 “Scene Analysis and Computer Vision”**. The change of lecturer was made due to a voluntary change in the lecturer’s workload and “transfer” of the course to younger colleagues. Significant changes in the delivery methodology or student feedback could not be observed.
- **DSP718 “Research Methods and Technical Writing”**. The change of lecturer was made due to the voluntary termination of the lecturer’s employment. The feedback has not changed significantly, thus the current quality has been maintained.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in

Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

In line with the academic excellence pillar of the RTU Strategy, several channels and formats of collaboration are available to academic staff. These include:

- **E-learning environment**: provides extensive functionality for collaboration between academic staff and students within specific courses. The most important functions are content management, management of assessment methodologies and grades, management of communication with students (in the form of questions, reports and assignments), management of tests and their results, among others. The e-learning environment also enables several academic staff to work simultaneously on the content of a specific course in the e-learning environment, thus enabling efficient use of electronic resources and providing the necessary support to students;
- **E-conferencing platforms**: (appropriately licensed ZOOM and MS Teams) providing technical support for daily collaboration - discussions, working meetings and simple exchanges of views that enable faculty to work together on a daily basis;
- **Annual academic conferences and seminars**, which allow discussing the latest trends in education methodology, its implementation, sharing experience among educators from different fields within the RTU team. Each year, the academic conference and various types of seminars allow updating important aspects of academic work, as well as learning from each other. Academic seminars are devoted to specific aspects of academic work, including the use of various interactivity tools, such as Interactive presentation software - Mentimeter, for the organization of the study process, discussion of different types of experience in the

development of graduation papers, as well as other issues. Academic seminars are organized as needed.

- **The Study Field Committee**, which provides an opportunity to discuss the curriculum, methods and results of studies, both among academic staff and industry representatives. Depending on the issues at stake, other faculties are also involved in the discussions and can make an important contribution to promotion of academic excellence. The sectoral committees are the most important platform for discussions on balancing and structuring the curriculum of different courses, allowing academic staff from different fields to discuss and decide on the content and format of studies.
- **Councils of Organizational Unit and Institutes** provide for a more specialized discussion between representatives of a specific field or study program on the aspects of implementation of specific study courses, including curriculum, assessment methodology, learning outcomes and other issues related to the implementation of studies;
- **Research platforms** provide a forum for the exchange of research ideas among faculty members and the opportunity to collaborate with each other, both in specific research and in the organization of research-based study courses. RTU has defined 6 research platforms, of which the Faculty of Computer Science and Information Technology participates in 4, which allows finding cooperation partners in different departments.

In order to promote cooperation among academic staff, several decision-making procedures are implemented. They include open discussion of issues in appropriate platforms, as well as participation in academic conferences or seminars as part of the set of criteria for assessing the quality of academic staff in accordance with the RTU methodology.

RTU Study Department, within the scope of its competence, promotes the responsibility of different specialization units for the study curriculum of the field they represent, i.e., a particular specialization unit, regardless of its affiliation to a particular faculty, provides study courses of its specialization within the study programs (regardless of the profile), in which the relevant courses are included. This promotes cooperation between fields in jointly implemented study programs and specialization within the respective fields at the same time.

Given the openness of the study program and the faculty as a whole, and the collaborative internal communication, it can be states that the collaboration between the academic staff of different specializations or departments is very good or excellent.

At the time of submission of the self-assessment report, the program has a total of 21 students and 16 educators (for different courses, including those taught jointly with students from other programs). Therefore, student/educator ratio is 16 / 21 = 0.76.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DMR0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DMR0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DMR0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DMR0(45526)_AIP_atzinums250stud_Intelekt_robot_sist.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DMR0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DMR0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMR0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_DMR0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DMR0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DMR0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DMR0(45526)_Plans_lv_Plan_eng.docx	P09_3.2.1_DMR0(45526)_Plans_lv_Plan_eng.docx
Descriptions of the study courses/ modules	A10_DMR0(45526)_StudyCoursesdescr_ENG.zip	P10_DMR0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Smart Electronic Systems (47523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Smart Electronic Systems*
Education classification code	*47523*
Type of the study programme	*Professional master study programme*
Name of the study programme director	*Dmitrijs*
Surname of the study programme director	*Pikuļins*
E-mail of the study programme director	*dmitrijs.pikulins@rtu.lv*
Title of the study programme director	*Doktors*
Phone of the study programme director	
Goal of the study programme	*To prepare specialists who understand the development trends of the industry in the world and are able to work in the field of research, development, installation, operation and modernization of smart electronic equipment and systems.*
Tasks of the study programme	*The tasks of the prof. master's study program "Smart Electronic Systems" are as follows:* *• to provide competitive education in the design of smart electronic systems in accordance with the level of master's studies and international standards;* *• to provide students with knowledge about the physical processes used in electronics and the technical solutions of circuits;* *• to ensure the development and changes of the content of the study program, realization of the study process, scientific research work, in accordance with changes in the fields of electronic systems design, international practice, science and didactic practice;* *• to provide students with comprehensive knowledge, develop skills and competence in accordance with the requirements of the market for electronics engineers, preparing students for practical work in the design, manufacture and maintenance of smart electronic systems;* *• to provide students with knowledge about the use of computer tools in the analysis and design of electronic systems;* *• to provide opportunities to acquire skills in research, problem formulation and analysis, innovation, strategy development, project definition and implementation, as well as organizational work, incl. theoretical and experimental research and literature analysis;* *• to promote students' interest in further professional development by providing knowledge and skills for independent study to increase their academic and professional qualifications.*

Results of the study programme	*Graduate of the professional master's study program "Smart Electronic Systems": • is able to develop circuit diagrams of electronic equipment and systems, make prototypes, perform their testing, analysis and improvement, observing the binding, industry-specific requirements of regulatory enactments and standards applicable to systems, processes and products; • is able to determine production technological processes, manage the production of electronic equipment and systems in accordance with technical documentation, standards and quality management system; • is able to conduct research with scientific value in the field of smart electronic systems, professionally systematize information, summarize, interpret and analyze research results, prepare summary reports and publications; • is able to apply current technologies and software in the design and production process of electronic equipment and systems; • is able to design electronic equipment and systems, perform their operation modeling, management software development; • is able to develop printed circuit boards, develop the corresponding technical documentation; • is able to evaluate human resources and create a project working group, delegate work tasks and control their execution, present the progress and results of the project; • knows at the level of understanding: current electronic equipment production technologies, electronics industry standards and technical norms; • knows electrodynamics, electromagnetic compatibility and antenna theory at the application level; • is familiar with analog and digital circuitry at the application level; • knows at the application level the theory of signal processing, the construction and design of transmission and reception equipment, as well as data transmission networks, sensors and actuators; • knows the programming of microcontrollers, signal processors, programmable logic circuits in a high-level language at the application level.*
Final examination upon the completion of the study programme	*State examination, which includes the development and public defense of a master thesis.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*

Admission requirements (in English)	*Bachelor degree of engineering science in electronics and automation, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Electronics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor degree of engineering science in electronics and automation, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Electronics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 1 years, 6 months - latvian

Study type and form	*Full time studies*
Duration in full years	*1*
Duration in month	*6*
Language	*latvian*
Amount (CP)	*60*
Admission requirements (in English)	*Professional bachelor degree in electrical science and professional qualification of electronic engineer, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Electronics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 1 years, 6 months - english

Study type and form	*Full time studies*

Duration in full years	*1*
Duration in month	*6*
Language	*english*
Amount (CP)	*60*
Admission requirements (in English)	*Professional bachelor degree in electrical science and professional qualification of electronic engineer, or comparable education and and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Master's Degree in Electronics*
Qualification to be obtained (in english)	*Leading electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The professional Master study program in the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science (from now on - the Study Program) has been implemented by Riga Technical University (RTU) since the academic year 2009/2010 under the code EGJ0 and the title "Electronics" and since the year 2018 under the code EGV0 and the title "Smart Electronic Systems". The duration of the studies was initially 2.5 years, and as a result of improvement, the program is implemented according to 2 versions from the academic year 2021/2022: 2 years and 1.5 years. The volume of the study program was initially 101 credit points (starting now referred to as CP), and according to the current versions, it is 80 CP and 60 CP accordingly, where the Master Thesis accounts for 20 CP. The volume and duration of the study program have been changed in compliance with Cabinet Regulations No. 793. 2.3.1 and 2.3.3. The program is implemented as full-time studies. According to the standard schedule of RTU, each academic year consists of 2 semesters. Each semester lasts for 16 weeks - 20 study weeks and 4 weeks of exam sessions. The study program is implemented in Riga at RTU Institute of Radioelectronics in Latvian and English.

The following significant changes in the parameters of the study program have been implemented since the last accreditation of the study direction in compliance with the expert recommendations:

1. The position of the Director of Study Program is now taken by Assoc. professor Dmitrijs Pikulins who has appropriate qualifications and experience in the development of the content of academic study programs;

2. The title and the code of the program have been changed.

3. The program was substantially revised by integrating the study courses of the academic study program “Electronics”, for example, RTR519 Integrated Devices and Their Applications, RTR512 Microwave Devices and Equipment etc., as well by supplementing it with new study courses, like RTR803 Signal Processing Systems, RTR804 Signal Processing Systems (Study work), RRI705 5G Wireless Technologies, RRI706 5G Wireless Technologies (study project), RTR801 Software Defined Radio, etc.

4. The duration of the studies, particularly the amount of CP, has been changed. Two versions of implementation of the program have been introduced: 1.5 years– 60 CP, if the professional Bachelor degree in Electrical Engineering and the professional qualification of the electronics engineer or similar education has been completed before, and 2 years – 80 CP, if the Bachelor degree in engineering in the field of electronics of automation or similar education has been completed before.

5. The degree to be conferred before – was the professional Master degree in electronics and the qualification of the electronics engineer, the degree to be conferred now - is the professional Master degree in electronics and the qualification of the Leading electronics engineer, in compliance with

the introduced standard of the leading electronics engineer.

6. The study program is currently implemented also in English.

7. The composition of the teaching staff has been modified and expanded.

Substantial improvement of the implemented professional Master study program is based on the recommendations from the previous accreditation. It was indicated that the difference between the academic Master and the professional Master study programs was small as regards theoretical knowledge to be acquired. Therefore, the implementation of only one program should be considered. The recommendations contained the instruction to encourage student exchange and develop long-term plans. Considering the above, the professional Master study program was improved in compliance with the modern industry trends by introducing new study courses in compliance with the developed long-term plans. It is worth mentioning that in the result of the implemented changes, the number of enrolled students and the number of graduates has increased, the program is provided in English by attracting foreign students, the number of ERASMUS+ mobilities for domestic students visiting foreign universities and for foreign students visiting RTU has been increased.

For the purpose of comparing the study programs, the study program as in academic year 2013/2014 is presented in the table below.

Study Courses	**1.sem.**	**2.sem.**	**3.sem.**	**4.sem.**	**5.sem.**	**Total**
[A] Compulsory Study Courses 26KP						**26**
Television Systems		2				2
Application of Microprocessors and Microcontrollers	3					3
Radio Receivers	2					2
Radio Receivers (Design Project)	2					2
Simulation and Analysis of Radio Electronic Circuits		3				3
Data Transmission Interfaces and Protocols		4				4
Radio Links	3					3
Study Project Radiolink		2				2
Scientific and Technical Information and Documentation		2				2
Mobile Telecommunication Systems		2				2

Basics of Occupational Safety		1					1
[B1] Field-Specific Study Courses 16KP							**17**
Radio Brodcasting	2						2
Electroacoustics	2						2
Fundamentals of Electronic Circuits	3						3
Electronic Communications	3						3
Security Systems and Technology		3					3
Innovation Management			2				2
Pedagogy, Psychology, Bussiness Etiquette		2					2
Other possible optional study courses:							
Equipment for Generation and Formation of Radio Signals – 3KP							
Transmission of Images – 2KP							
Application of Signal Processors – 3KP							
REI EMS – 2KP							
Application of Integrated Circuits in Broadcasting Equipment– 2KP							
Digital Video Transmission Systems – 3KP							
Project Design and Supervision– 3KP							
C.Practical Placement 32 KP							**32**
Practical Placement			18	8			26

Practice (design)				6		6
D.Final Examination 26KP						**26**
Master Thesis Including Project				6	20	26
	20	21	20	20	20	**101**

Initially, the total volume of the study program was 101 CP, of which 26 CP were compulsory study courses and 75 CP were distributed as follows: the compulsory elective courses of 17 CP, the Internship of 32 CP and the Master's Thesis with the design part of 26 CP. In compliance with the specifics of the study program, all the study courses could be split into the following thematic groups:

- Scientific-technical base study courses: Television Systems, Application of Microprocessors and Microcontrollers, Radio Receivers, Simulation and Analysis of Radio Electronic Circuits, Data Transmission Interfaces and Protocols, Radio Links, Mobile Telecommunication Systems, Radio Receivers (Design Project), Study Project Radiolink;
- Compulsory elective humanities and social, teaching or economics and management study courses: Scientific and Technical Information and Documentation, Basics of Occupational Safety, Innovation Management (e-study course), Project Design and Supervision, Pedagogy, Psychology, Bussiness Etiquette;
- Specialisation study courses: Radio Brodcasting, Electroacoustics, Fundamentals of Electronic Circuits, Electronic Communications, Security Systems and Technology, Equipment for Generation and Formation of Radio Signals, Transmission of Images, Application of Signal Processors, Electromagnetic Compatibility of Radio Devices and Systems, Application of Integrated Circuits in Broadcasting Equipment, Digital Video Transmission Systems.

Specialisation courses provided in-depth studies focused on: radiophonics, TV program creation, transmission and reception, and the electronic devices for mobile communications; software engineering of programmable embedded systems (microprocessors, controllers, computers) and their application in various electronic systems.

The volume of the compulsory study courses in the improved professional Master study program is 23 CP. The volume of compulsory elective courses - professional specialisation study courses, is 11 CP. Students select from among 14 study courses, the total volume of which amounts to 38 CP. The professional study courses conform to two basic directions of the electronics industry, namely, the smart embedded systems, which comprise software engineering of microprocessors, software engineering of reconfigurable logic massives, design of integrated circuits; and smart wireless communication systems, which comprise 5G wireless technologies, data transmission on wireless sensor networks, program-controlled radio systems, microwave technique, signal processing. In compliance with selected and completed study courses, more narrow specialisation is possible within both basic directions.

The current content and analysis of the study program are presented in Section 3.2.1.

The changes and analysis of the staff involved in the implementation of the program are presented in Section 3.4.2

Changes made in the professional Master study program are described in Annex 9.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The professional Master study program "Smart electronic systems" prepares highly qualified electronics experts with an extensive profile who understand the global industry development trends and can work in research, development, installation, operation and modernisation of smart electronic devices and systems.

The content and implementation of the study program corresponds to code 47523:

47 – The study program "Smart electronic systems" provides second-level professional higher education - prof. master's degree; students are admitted after bachelor's or prof. obtaining a bachelor's degree; the duration of studies is 1,5 or 2 years, depending on the previously acquired education.

523 – > Engineering, production and construction >Engineering and technology> Electronics and automation

The content of the study program corresponds to "Electronics and Automation", including analog and digital electronics, embedded systems (MCU, FPGA, etc.), signal processing, equipmentcontrol, process automation.

The title of the study programme “Smart electronic systems” perfectly conforms with the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science, as electronics is included in the title of the field as its indispensable part, and smart systems combine the application of information and communication technologies, because modern smart systems cannot exist without information transmission and processing.

The study program is implemented in two versions: 60 CP, if the professional Bachelor degree in electrical science and the professional qualification of the electronics engineer or similar education has been completed before, and 80 CP, if the Bachelor degree in engineering in the field of electronics of automation of similar education has been completed before. Accordingly, the duration of studies is 1.5 years in the version of 60 CP and 2 years in the version of 80 CP because students have additional Internships amounting to 20 CP. The other study courses and types of examinations are the same in both versions of the program's implementation, including the Applied research internship and the Master's Thesis.

The program graduates receive the professional Master degree in electronics and the professional qualification of a leading electronics engineer.

Experts are trained for the two directions of the science field of electrical engineering, electronics, information and communication technology: smart embedded systems and smart wireless communication systems. The title of the study program, "Smart electronic systems", perfectly conforms with the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science, as electronics is included in the title of the field as its indispensable part, and smart systems combine the application of information and communication technologies, because modern smart systems cannot exist without information transmission and processing.

The aim of the program is prepare specialists who understand the development trends of the industry in the world and are able to work in the field of research, development, installation, operation and modernisation of smart electronic equipment and systems.

The tasks of the prof. master study program "Smart Electronic Systems" are as follows:

- to provide competitive education in the design of smart electronic systems in accordance with the level of Master studies and international standards;
- to provide students with knowledge about the physical processes used in electronics and the technical solutions of circuits;
- to ensure the development and changes of the content of the study program, realisation of the study process, and scientific research work, in accordance with changes in the fields of electronic systems design, international practice, science and didactic practice;
- to provide students with comprehensive knowledge, develop skills and competence in accordance with the requirements of the market for electronics engineers, preparing students for practical work in the design, manufacture and maintenance of smart electronic systems;
- to provide students with knowledge about the use of computer tools in the analysis and design of electronic systems;
- to provide opportunities to acquire skills in research, problem formulation and analysis, innovation, strategy development, project definition and implementation, as well as organisational work, incl. theoretical and experimental research and literature analysis;
- to promote students' interest in further professional development by providing knowledge and skills for independent study to increase their academic and professional qualifications.

Graduate of the professional Master's study program "Smart Electronic Systems":

- is able to develop circuit diagrams of electronic equipment and systems, make prototypes, perform their testing, analysis and improvement, observing the binding, industry-specific requirements of regulatory enactments and standards applicable to systems, processes and products;
- is able to determine production technological processes, manage the production of electronic equipment and systems in accordance with technical documentation, standards and quality management system;
- is able to conduct research with scientific value in the field of smart electronic systems, professionally systematise information, summarise, interpret and analyse research results, prepare summary reports and publications;
- is able to apply current technologies and software in the design and production process of electronic equipment and systems;
- is able to design electronic equipment and systems, perform their operation modelling, management software development;
- is able to develop printed circuit boards and develop the corresponding technical documentation;
- is able to evaluate human resources and create a project working group, delegate work tasks and control their execution, present the progress and results of the project;
- knows at the level of understanding: current electronic equipment production technologies, electronics industry standards and technical norms;
- knows electrodynamics, electromagnetic compatibility and antenna theory at the application level;

- is familiar with analog and digital circuitry at the application level;
- knows at the application level the theory of signal processing, the construction and design of transmission and reception equipment, as well as data transmission networks, sensors and actuators;
- knows the programming of microcontrollers, signal processors, programmable logic circuits in a high-level language at the application level.

The possible internship places for students and employment opportunities for graduates:

SAF Tehnika, SIA Mikrotīkls, Arcus Elektronika, Latvijas Radio un Televīzijas Centrs, Latvijas Radio and Latvijas Televīzija, Lattelekom, Latvijas Mobilais Telefons, Tele2, Elektronisko Sakaru direkcija, a/s “Alfa”, SIA “Hanza Elektronika”, Accenture, UAV Factory, Citrus Solutions, Draugiem Group, Intelligent Systems, Vizulo, Regula Baltia, Aerones.

The content of the master's study program meets the standards of international education, and the implementation of the program was also started in English. Statistical data show that the Master's study program "Smart Electronic Systems" attracts an increasing number of students.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The electronics industry is undergoing rapid development. Thanks to the continuous emergence and introduction of new technologies, substantial transformations occur every year in the industry. According to the recent forecast, there will be substantial development in the electronics industry during the next 7 years, and the common market will grow by 50-60%. Also, during COVID-19 pandemic, the development of the ICT sector increased, thus creating additional development opportunities (for example, the increase of the Chinese market of semiconductor production amounts to 30.6%).

By following the recent trends and forecasts, also Latvia is developing relevant development strategies and concepts by providing the possibility to focus on resolving issues important for the national economy:

- Sustainable development strategy of Latvia until 2030;
- Smart specialisation strategy;
- Guidelines of development of science, technologies and innovations 2021-2027.

The first standard of the profession of the leading electronics engineer was developed and approved in Latvia in 2021.

The above-referred documents also enable higher education institutions to perform substantiated development and improvement of study programs preparing the high-level experts in particularly important or prospective sectors for the state.

Nowadays, electronic functional units are integrated in a broad range of commonly used devices (mobile telephones, cars, video cameras, etc.) and industries (the Internet of Things, robots, etc.). The new communication technologies (5G and 6G in the future) provide efficient connection to the Internet by using the micro wave range and state-of-art signal coding and transmission methods. This means that a modern electronics engineer should possess knowledge and skills in all the above fields.

The professional Master study program "Smart electronic systems" has been developed in response to the industry development trends the requirements defined by employers and the Smart Specialisation Strategy set in Latvia.

The study program is intended to train leading electronics engineers who can work in research, development, installation, operation, and modernisation of electronic devices and systems. Within the scope of the study program, students also learn the systemic basics of organisation and implementation of research work and are prepared for Ph.D studies.

Implementation of the study program comprises two basic specialisations by providing an opportunity to gain knowledge and skills on both topical directions of development of the national economy, as well as perspective directions which cannot be found in the content of other study programs:

- ***Smart embedded systems***, which include programming of microprocessors, systems with reconfigurable logic gates, development of integral circuits;
- ***Smart wireless communication systems***, includes 5G wireless technologies, data transmission on wireless sensor networks, software defined radio systems, microwave technique.

Experts from numerous Latvian electronics companies and organisations were involved in implementing the study program: HansaMatrix Innovation, SAF Tehnika, Citintelly, ADI, Draugiem Group, the Institute of Electronics and Computer Sciences, etc.

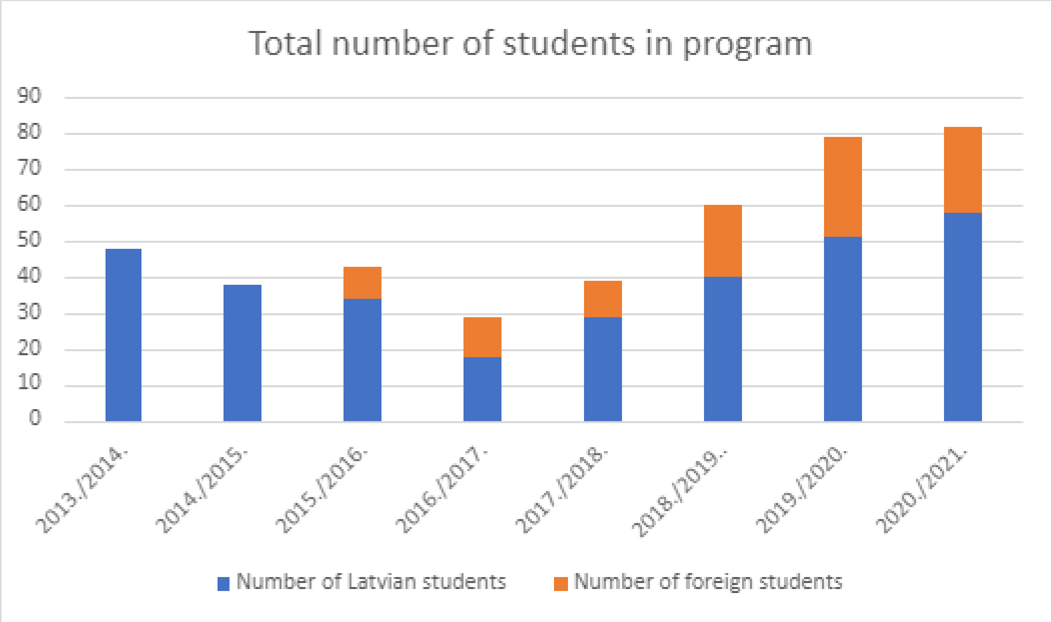
Upon completion of the studies the graduate obtains the professional Master degree and the electronics engineer qualification; knows the application of modern electronic tools and software; is able to design and implement embedded and wireless communication electronic systems, is able to develop technical documentation, is able to carry out scientific research activities, is able to develop and implement projects; is able to work in a team, to communicate with other experts; understands innovations, basics of business and marketing.

The employment of the graduates of the study program is provided by the companies of the Latvian Information and Communication Technology industry (ICT), for example: AS "SAF Tehnika", SIA "Mikrotīkls", VAS "Latvijas Valsts Radio un Televīzijas Centrs", , SIA "TET", SIA" Latvijas Mobilais Telefons", SIA "Tele2", VAS "Elektroniskie sakari", AS "Alfa", AS "HansaMatrix", SIA "HansaMatrix Innovation", Accenture Latvijas filiāle, SIA "UAVFactory", SIA "Citrus Solutions", AS "Draugiem Group", SIA "Intelligent Systems", SIA "AERONES", SIA "Vizulo", SIA "Regula Baltija", SIA "Baltic Scientific Instruments" etc.

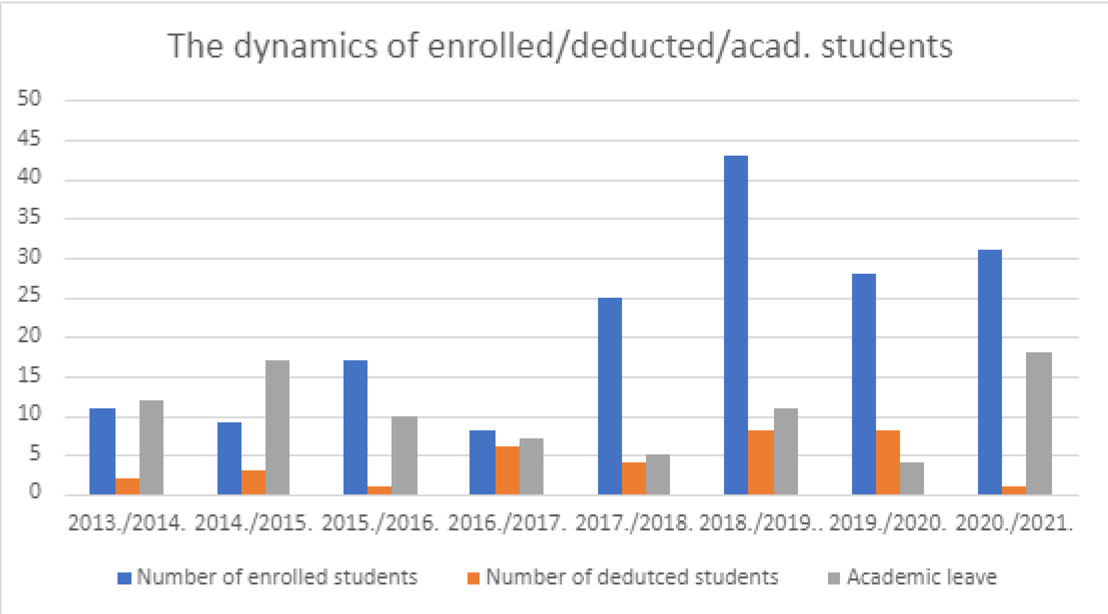
The development and implementation of the study program are based on the RTU Strategy 2022.-2025 focused on implementing the study process based on science, innovations and in cooperation with the industry providing training of the experts needed for the Latvian national economy, thus serving as the basis of the sustainable development of Latvia.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The changes in the number of students in the professional Master study program "Smart electronic systems" are closely related to several processes: development of the electronics industry in Latvia, awareness of students as regards the possibilities of employment and studies, the number of graduates of the Bachelor program, the demographic situation in the country, the decisions taken by the program management regarding development of the study program.

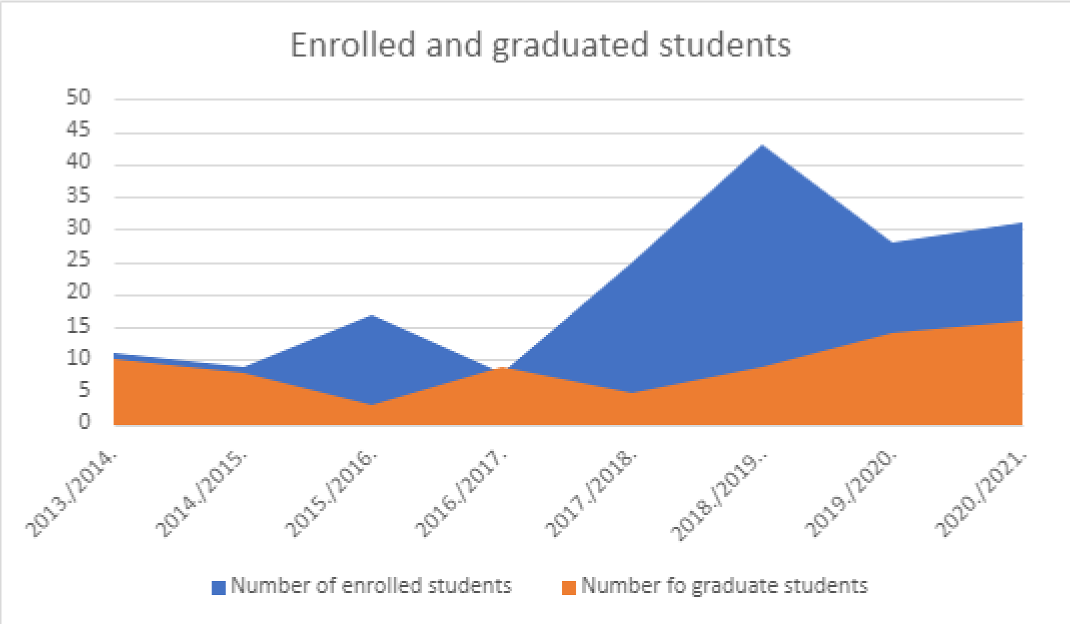


The graph demonstrating the trends in the total number of students indicates that the period from 2013 to 2018 was characterised by stable decrease of the number of students, even irrespective of the fact that admission of foreign students to the program was started in 2015. This was mainly related to the obsolete content of the program and the low interest of students. The program was revised in 2018 by excluding obsolete study courses, and adding courses from the academic Master program "Electronics". The program's title was changed the same year from "Electronics" to "Smart electronic systems". All the above-listed factors allowed for a considerable increase in the total number of students in the program, Latvian and foreign. The insignificant decrease in the number of foreign students can only be seen in the academic year 2020/2021 when international students left and several domestic students discontinued studies because of COVID-19 restrictions.



The changes in the number of enrolled students present a stable positive development trend since the implemented program restructuring. It should be noted that in 2021 two versions of implementation of the study program were introduced: 80 CP and 60 CP, admitting the graduates of the professional Bachelor study program, and second, allowing completion of studies within a shorter period and receiving a new qualification of the leading electronics engineer. The above-referred measures again increased the interest in the study program.

The graph also presents data about the students using academic leaves. The number of students using the academic leave was particularly high in the academic year 2020/2021 when, due to COVID-19, some students interrupted their studies, and some others used academic leaves awaiting for stabilisation of the situation and return to personal classes.



The changes in the number of graduates allow concluding that the number of graduates in the study program has increased lately. However, not all the students complete their studies. A part is exmatriculated because of failing grades or according to their wish. A failure to complete the study program at later stages is mainly related to employment opportunities. Students find suitable and well-paid employment during the first study years, as they master practical skills related to the development of smart electronic systems and cannot devote so much time to studies. It should be noted that the study program also provides for the compulsory Internship in a company, which allows not only improving the qualification of studies, but also provides an opportunity to find a stable job, sometimes even resulting in quitting studies.

The data analysis allows drawing the overall conclusion that there is a positive trend of increase in the number of students within the study program, which refers to both domestic and foreign students. This conforms to the general development trend of the electronics industry and a stable increase in demand for the industry experts in the labour market. The number of students indicates a stable positive trend attesting to the correctness of the development strategy selected by the program management and allowing planning of further program development.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The professional Master study program "Smart electronic systems" is implemented in twoversions according to the study courses completed on the Bachelor study level:

1. 60 CP – for the graduates of the professional Bachelor study program with a successful internship of at least 20 CP - received a professional bachelor’s degree in electrical engineering and qualification of electronics engineer or similar education. Duration of the Master studies - 1.5 years;

2. 80 CP – for the graduates of the academic Bachelor program - received Bachelor degree in engineering in electronics and automation or similar education. Duration of the Master studies - 2 years.

The volume of the compulsory study courses in the study program is 23 CP. The volume of compulsory elective courses - professional specialisation study courses, is 11 CP. Students select from 14 study courses, the total volume of which is equal 38 CP. The professional study courses conform to two basic directions of the electronics industry, namely, the smart embedded systems, which comprise programming of microprocessors, software design for field-programmable gate arrays, and development of integrated circuits; and smart wireless communication systems, which comprise 5G wireless technologies, data transmission on wireless sensor networks, software-defined radio systems, microwave technique, signal processing. In compliance with selected and completed study courses, more narrow specialisation is possible within both basic directions.

According to both versions of the program's implementation, the volume of compulsory study courses and professional specialisation study courses in the study program is the same. The main difference relates to the completion of the Internship. In the version of 80 CP, students complete the Internship for 20 CP and the applied research internship for 6 CP. In the version of 60 CP, students only have the applied research internship. Master's Thesis for 20 CP.

Both versions of the program are implemented as full-time studies in Latvian and English.

The program graduates receive a professional Master degree in electronics and the professional qualification of a leading electronics engineer.

Table of the presented study content program:

Cell CP [1] credit points for version 1 with 60.0 credit points

Cell CP [2] credit points for version 2 with 80.0 credit points

No	Code	Name	C.p. [1]	C.p. [2]
A		**Compulsory Study Courses**	**23.0**	**23.0**
1	RRI702	Application of Microprocessors and Microcontrollers	3.0	3.0
2	RTR519	Integrated Devices and Their Applications		
3	RTR803	Signal Processing Systems	3.0	3.0
4	RTR804	Signal Processing Systems (Study work)	2.0	2.0
5	REA707	Digital Electronic Systems Design	3.0	3.0
6	RRI707	Electronic Systems for Data Transmission	3.0	3.0
7	RTR512	Microwave Devices and Equipment	3.0	3.0
8	RTR802	Advanced Electromagnetic Simulations Methods and Software		
9	RTR832	Simulation of Functional and Logical Circuits	3.0	3.0
10	REA703	Data Transmission in Wireless Sensor Networks	3.0	3.0
11	ICA104	Civil Defence*		
B		**Compulsory Elective Study Courses**	**11.0**	**11.0**
B1		**Field-Specific Study Courses**	**11.0**	**11.0**
1	RRI405	Electroacoustics	2.0	2.0
2	RRI465	Electromagnetic Compatibility of Radio Devices and Systems	2.0	2.0
3	RRI495	Electronic Communications		
4	REA407	Design Technologies	3.0	3.0
5	RTR702	Integrated Circuit Design. Part 1	3.0	3.0
6	RTR703	Integrated Circuit Design. Part 2	2.0	2.0
7	RTR801	Software Defined Radio	3.0	3.0
8	RTR710	Signal Processing in Heterogeneous Systems Containing FPGA	3.0	3.0

9	RRI708	Design and Documentation of Electronic Equipment	3.0	3.0
10	RRI488	Innovation Management	2.0	2.0
11	RTR808	Impedance Spectroscopy in medicine and technology	3.0	3.0
12	RRI705	5G Wireless Technologies	3.0	3.0
13	RRI706	5G Wireless Technologies (study project)	2.0	2.0
14	RTR802	Advanced Electromagnetic Simulations Methods and Software	4.0	4.0
15	RTR819	Microelectronic Devices in Analogue Circuit Design	3.0	3.0
D		**Practical Placement**	**6.0**	**26.0**
1	RRI715	Internship		20.0
2	RRI714	Applied Research Internship	6.0	6.0
E		**Final Examination**	**20.0**	**20.0**
1	RRK002	Master Thesis	20.0	20.0
2	RRI011	Master Thesis Including Project		

*If a student has not acquired the requirements stipulated by the Law on Environment Protection and the Law on Civil Defence within the scope of a lower level study program, these are acquired in addition to the study program volume.

**Only for foreign students who acquire the study program in English. This study course will be completed in addition to the study program volume.

The theoretical and practical base for acquiring the courses during later semesters is provided to the students during the first semester. Therefore, there is more focus on learning the analog and digital circuits, theory of signals, basics of the data transmission systems, and programming of processors in a high-level language and data transmission in wireless sensor networks. Students learn to apply modern software for engineering and simulation of electronic systems during study courses.

During the second semester, the study courses, including the state-of-art technological achievements in several fields, are completed: 5G technologies, FPGA and FGPA +SoC programming, simulation of electromagnetic fields, and software-defined radio. Students learn to carry out the design of printed circuit boards by developing relevant technical documentation and obtaining in-depth knowledge in advanced circuit design techniques, software engineering, and signal processing. The outcomes of the above courses cover a broad range of knowledge and skills to be acquired by focusing mainly on the solution of the problems of electrodynamics and antenna theory, digital circuit design, advanced signal processing and data transmission. Achievement of the above outcomes requires mastering additional skills for applying the specific software for the design, simulation and programming of electronics systems. At the same time, students' competence in developing and testing various prototypes is improved. Students are taught production technologies of electronic devices, the industry standards, drafting of documents. Students' competence in defining technological processes and management of system production is improved.

The study program implementation differences start from the second study semester. There is the applied research internship of 6 CP, and students have to start working on their graduation paper in the version of 60 CP. In the version of 80 CP, students start the Internship in the second study semester, which will continue during the next semester and total amount to 26 CP.

In the version of 60 CP the third semester is the last study semester which students use for developing their Master Thesis and simultaneous acquisition of the study course of innovation management, which develops the student's creative thinking, provides necessary knowledge and skills of analysis of the innovation processes in electronics and telecommunications or deepening their knowledge in the development of integral schemes or electroacoustics.

In the version of 80 CP, in the third semester, students complete their Internship and simultaneously complete the study course of innovation management.

The fourth semester is only included in the version of 80 CP, and students use the last study semester for developing their graduation paper.

The study program, courses, and content are continuously improved by involving young experts, teaching staff, and PhD students. For instance, within the scope of project SAM No. 8.2.2.0/18/A/017 the following study courses were improved: RRI705 5G Wireless Technologies with materials - lecture presentations, tests, video lectures; and RRI706 5G Wireless Technologies (study project) - descriptions of laboratory assignments, materials of practical assignments and scripts were upgraded.

The overall analysis allows concluding that the envisaged attainable outcomes of the study program are covered in a balanced way without overlapping, as, during the study courses of the beginning stages of studies, students acquire a particular knowledge base (by mastering relevant knowledge, skills and improving their competence). The students acquire in-depth knowledge during later study courses and improve their competence in specific and complicated sub-fields. Materials of the study courses are supplemented in compliance with the development trends of the electronics industry and its subfields.

Analysis of information included in study courses/modules, achievable results, set goals, etc. the evaluation of the interlinking of the indicators with the goals and achievable results of the study program is reflected in Appendix 8.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The professional Master study program "Smart electronic systems" is the only program in Latvia providing training of highly qualified experts of international level holding the professional Master degree in electronics and the qualification of the leading electronics engineer. In the study program, there are both: state budget funded seats and tuition fee covered seats. The study program costs have been calculated in compliance with the established practice at RTU and do not exceed the costs of training per student in the relevant speciality in EU Member States. Studies within the program are implemented as full-time studies in Latvian and English.

The study program was developed and is being improved in compliance with the RTU strategy and RTU research program. The task of the RTU Strategy and Development Program 2021-2025 is to implement the priority included in the National Development Plan 2021-2027 "Knowledge and skills for personal and national growth". The study program allows training of professional Master degree students who will be able to work in various Latvian and foreign companies, universities, research institutions and other organisations where research knowledge, skills and competencies in electronics are required.

The outcomes of the study program are defined in compliance with the requirements defined by the profession standard "Leading electronics engineer" by structuring the outcomes according to the knowledge, skills, and competencies to be acquired.

The Internship process is regulated by the RTU Procedure of the Internship organisation, which fully conforms with the Minister Cabinet Regulations. RTU signs the agreement on the provision of study internship with a company or organisation accepting students for Internship.

The goals defined in the descriptions of study courses are closely linked to the attainable results of the program as a whole. The content of the study courses fully conforms to reaching the study outcomes. The content of study courses is regularly checked and improved, which helps to control and renew the study content and teaching methods and update the study outcomes to be attained.

The main research directions of the program are based on the EFT development strategy and the main sub-directions. The defined research directions develop within the framework of scientific projects of various levels. The teaching staff involved in the development of the Master program also actively participate in scientific-research activities and hold both academic and scientific positions. To attain the research goals both in projects and in research directions, students of Bachelor and Master programs are also involved with graduation papers, in positions of assistants of research activities and within the scope of aid grants. Topics of graduation papers are analysed and summarised in Section 3.26 and are as follows: Electroacoustics; Signal and image processing; Electronics elements, measurements; Embedded systems; RF and wireless communication systems. During the last three years, the Institute of Radioelectronics has had considerable achievements in its scientific activity regarding approval of scientific projects, including grants to Master students, and an increased number of publications, including the number of Master students as co-authors. The achievements of the teaching staff of the Institute of Radioelectronics were also appreciated on the RTU level by granting awards to “Young teaching staff” and “Young scientists” in 2019 and 2020. The research results are also actively integrated into study courses.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Implementation of the study program is based on the principles of student-focused education. The professional Master study program "Smart electronic systems" is adapted to applicants from both the engineering professional Bachelor programs and academic programs. It is implemented in the official state language and English.

During the studies the possibility is provided to acquire study courses in various ways by applying diverse teaching methods, including the remote study process, providing lectures, practical assignments, laboratory assignments and their public presentation, testing and evaluation of the independent work, developing the study projects based on mastering of engineering activities or research skills. The diversity of study methods allows students to acquire new knowledge and skills as efficiently as possible while also developing their inquiring abilities.

Students are actively encouraged to get involved in scientific activities, for example, by learning to present the research results of study projects as scientific articles, and the best articles are published in the collections of articles of international conferences. All the Master students are obliged to participate in the RTU Student conference. Students are encouraged to participate in guest lectures and international conferences organised by RTU.

Taking into account students' individual interests, several study courses provide the possibility to choose assignments for course papers and course projects, the topic for the Master's Thesis and the individual internship plan.

During the studies, opportunities are provided to learn to work in a team by working on study papers, laboratory assignments or individual assignments in groups, as well as to master skills of independent work by solving various assignments, including assignments of the open type independently, by only contacting the teaching staff for consultations.

International study experience is provided by offering mobilities to students (e.g., within ERASMUS+ mobility) and actively accepting foreign exchange students in the study program (e.g. from France). To make the mobility of local students easier, an individual study plan is prepared for students, and on-site and remote guest lectures by the teaching staff from European universities are organised within various study courses.

The study program is also implemented in English, targeting international students. All study courses are provided with study materials in English. The description of each study course also indicates the literature in English available in the library. All teaching staff conducting study courses for international students have corresponding knowledge of English.

High quality and efficient assessment of students is provided in compliance with the Regulation on the Assessment of Learning Outcomes (Only in latvian) (https://www.rtu.lv/writable/public_files/RTU_1_studiju_rezultatu_vertesanas_nolikums.pdf) and the Regulations on Final Examinations at Riga Technical University (Only in latvian) (https://www.rtu.lv/writable/public_files/RTU_nolikums_par_noslguma_prbaudjumiem_.pdf).

Considering the Regulations:

- Study goals and the student's study outcomes at the end of the course are clearly defined in the course description for every study course. The requirements for successful completion of the course and the criteria for assessment of outcomes are also defined. Upon starting a study course, the professor informs students about the course requirements and assessment criteria during the first class.
- During the study process, every student receives an individual assessment of the achieved

results in a test, an exam paper, laboratory assignment, etc., either directly from the professor or within the course environment in Moodle system. If there are any questions or objections, the student can contact the professor and receive clarifications. An independent reviewer is assigned to assess more extensive study courses (Internship, graduation papers, etc.), and a commission is set up for public presentation.
- The final grade is based not only on the examination. Students' continuous progress during the whole academic year is taken into account (tests, home assignments, laboratory assignments, etc.), thus allowing them to carry out an objective assessment of the attainment of expected study outcomes by students.

To develop graduation papers, students have access to many RTU laboratories and specially equipped premises where students can work independently. Moreover, within the scope of cooperation between the RTU and the industry or other research institutions, possibilities are provided to develop the Master's Thesis outside the RTU, perform experimental research and activities, and approbate the research results by using the infrastructure of RTU partners. For more efficient development of graduation papers and receiving a higher final grade, regular workshops (several times during a semester) are arranged for students where they have to present the results of the development of their graduation papers. The teaching staff comments on the work progress and implementation and indicates possible solutions to issues. The defence of the Master Thesis takes place at the state commission, where the chairperson and the deputy chairperson are the industry representatives, and a minimum 50% of the commission members are the industry representatives, in this way providing an objective assessment of the students' professional competences.

Students can provide an anonymous assessment of the relevant course following its completion by providing feedback to improve the quality of the study course, adapting the content and teaching methodologies to the students' expectations. The anonymous survey results are discussed at the methodological seminars of the Institute and departments. Students not only provide the feedback but are also involved in the processes of development of new study courses and the development of the structure and content of the study program within the scope of the faculty council and relevant working groups.

Courses and workshops on modern teaching and study methods are organised for the teaching staff. The attendance of qualification improvement courses at the internal faculty events and on RTU and international levels is encouraged. The staff of the Institute of Radioelectronics actively uses the opportunities provided by ERASMUS+ for mobility to the European universities for experience exchange and improvement of qualifications. RTU Centre of Academic Excellence organises teaching staff tuition events at the university level. The teaching methodologies and the possibilities of using modern technologies to improve the study process are also discussed within the Institute and department meetings.

The materials and applied methods within the program are overall suitable for attaining the outcomes of the study program and provide sufficient diversity for the use of the student-focused teaching practice on a daily basis.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign

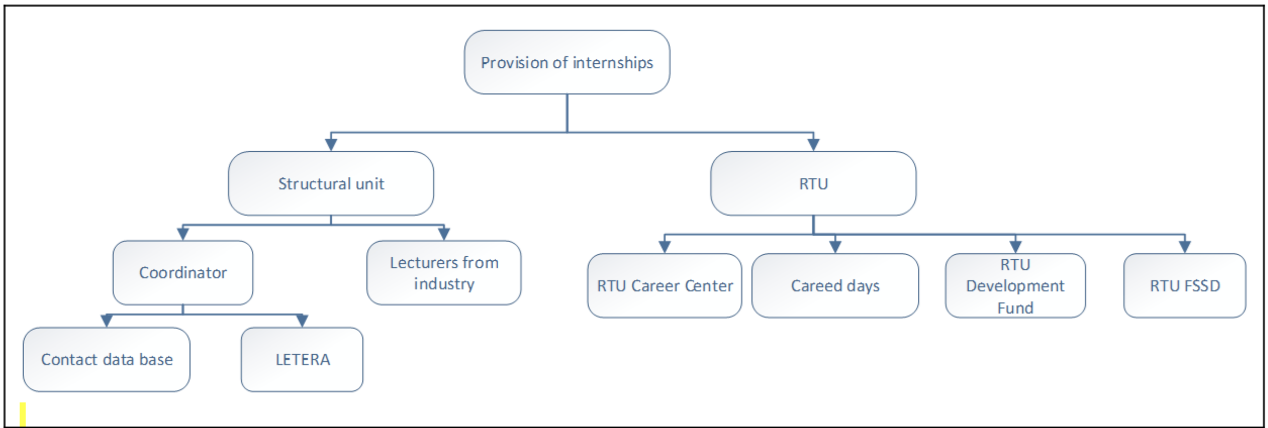
students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

After completing theoretical courses, students use practical placement to detail and strengthen their professional knowledge. The Internship aims to provide the practical work experience needed for receiving the professional qualification for the student at a company or institution of electronics profile outside RTU.

During the Internship, students get acquainted with the structure and work organisation of the internship company and the technical-economic performance. Students have an opportunity to learn the modern scientific and innovative technical solutions in smart electronic systems and get acquainted with labour safety, safety technique, environmental protection and electromagnetic compatibility standards, and their technical and organisational solutions.

The tasks of the student internships included in the study program are formulated according to the study results to be achieved in the study program.

Students present the assignments completed during the Internship in their report.



Scheme of provision of internship placements

The Internship is organised in compliance with the Senate decision on the Procedure of the organisation of the Internship at RTU. As defined in the procedure of the internship organisation, the internship coordinator in the corresponding structural unit assists students in finding an internship placement. As a result of providing students' internships at companies for many years, the list of potential industry companies and organisations, including the updated database of contacts, is developed and maintained in the structural unit.

The Latvian Electrical Engineering and Electronics Industry Association (LETERA), with approximately 95 active members registered as of the beginning of 2022 - large and small companies of the industry, also provides important support for internship placements.

For the provision of the study process of the professional program, many practising industry experts are involved as lecturers and assistant professors who have direct contact with students and offer internship placements in their companies.

If additional assistance is needed, it is possible to contact the Division of Career Support and Services where a career consultant and a project manager helps students to find internship placements and to contact them, as well as implement various events to contribute to development of career management skills, which can ensure successful results in the internship process. Once a year, the Division of Career Support and Services organises the RTU Career Day, where students can meet company representatives and speak about future opportunities. See more details about the event and participants of preceding years: http://karjera.rtu.lv/projekti/karjeras-dienas-arhivs/.

An additional resource developed since 2015 is a website where companies are invited to post their vacancies interesting for RTU students (https://ekarjera.rtu.lv/). Students can connect with the university user name and follow current internships and employment opportunities in their industry.

The RTU Development Fund also supports promoting practical skills (https://www.rtu.lv/lv/attistibasfonds). During the year, several hundreds of competitions to improve practical skills are offered and organised in cooperation with companies and provide an opportunity for students to learn practical skills.

Within the scope of the professional Master study program, depending on the program version (60 CP or 80 CP) the following study courses are provided: ***Internship*** and/or ***Applied research internship***. For students who have previously completed the professional Bachelor study program, including the Internship, it is only necessary to attend the Applied research internship aimed at provision of the additional practical work experience in a company or institution of the electronics profile. Thus, the student acquires the professional qualification to develop the electronics Master project with a practical section successfully.

Applied research internship tasks are: • To acquaint the student with the latest scientific and innovative technical solutions used to improve the quality of equipment to be developed and produced, increase labour productivity, and reduce costs to increase the competitiveness of manufactured or offered products in the market. • To involve the student in scientific research work in an internship company. • To develop students' skills to summarize and systematize information, evaluate research results and compile materials for Master thesis. • To provide an opportunity to specify the title of a possible Master's Thesis topic.

The necessity of the additional research internship is provided by the requirements of the new professional standard of the Leading electronics engineer, according to which the graduates of the professional program have to be able to perform scientific research work:

- perform research of electronic devices, systems, and relevant materials, processes and technologies (to perform the analysis of the issue status, to substantiate the selection of the research method, to perform computer simulation and experiments);
- independently define and research complicated scientific issues; supervise research work;
- prepare reports on research results in the industry and professional activity;
- integrate the knowledge of various fields by contributing to the development of new knowledge, methods of research or professional operations.

The applied research internship is implemented to allow students to acquire the above-referred skills. Students can complete this Internship at both research institutes and companies engaged in research work or participating in the implementation of scientific projects.

Provision of Internship for foreign students is organised in the same way as for local students. Additional support is provided for the Department of International Cooperation and Foreign Students (SSĀSD), which participates in negotiations with students and potential internship providers by explaining formal requirements as necessary.

Considering that the Internship is organised at later study stages, students have an additional opportunity to develop their graduation paper at the company where they have Internship and continue working in the company selected for Internship later.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

All topics of graduation papers during the period 2013-2021 are summarised in the tables. Papers are also divided according to thematic fields.

In the professional Master study program "Smart electronic systems", the topics of graduation papers are mainly determined by the needs of the industry. This is related to the fact that the last year's students have their internship during the last study semesters and start working on their Master Thesis simultaneously. Representatives of companies propose the themes of graduation papers to most students, thus ensuring that they conform to the topicalities in the industry.

Academic year 2013/2014	
Thesis title	**Thematic field**
Acoustic design of a room in a boarding school for hearing-impaired students	Electroacoustics
Power stage of a digital TV transmitter	Signal and image processing
Data transmission in the DWDM system	
Device for measurement and adjustment of potassium concentration	Electronics elements, measurements

Heating control for smart homes	Embedded systems
Autonomous security system	
Street lighting control system	
Multifunctional indicator for transportation of goods delivery	
Control system for an interactive game	
Ventilation system with wireless temperature monitoring	

Academic year 2014/2015

Thesis title	Thematic field
RFID system laboratory equipment	RF and wireless communication systems
Multiple band antenna module for a car	
Measurement of dynamic characteristics of electro cardiogram	Signal and image processing
Rail-to-rail OP input parameter dependence on the in phase voltage	Electronics elements, measurements
Autonomous CCTV system	Embedded systems
Timing for sledging sports	
LED lighting for stage	
Smart parking	

Academic year 2015/2016

Thesis title	Thematic field
Remote control boat equipment for fishery	Embedded systems
Universal unit for a house automation system	
Laboratory work in security systems	
Frequency transformer for various electric engines	
Security alarm	

Academic year 2016/2017

Thesis title	Thematic field
Device for restricting operation of mobile telephones	RF and wireless communication systems
Real-time multi-frequency generator	
Determining the coordinate of a waveguide inhomogeneity	
Printed circuit board testing station	Electronics elements, measurements
Luminescence kinetics measurement device	
Modern operational amplifiers in high-frequency devices	
Electronic control of a 20kV sub-station	Embedded systems

Academic year 2017/2018

Thesis title	Thematic field
The receiver of weak signals	RF and wireless communication systems
Unmanned meteo station telemetrics and power supply	Embedded systems
Telemetrics device for room cleaning equipment	

Academic year 2018/2019

Thesis title	Thematic field
Controllable multi-band hearing corrector	Electroacoustics
Distance sensor for the manipulator UR5	Electronics elements, measurements
Wireless power supply system	
Wireless charging for moving objects	
Line type temperature sensor	
Room air improvement device	Embedded systems

Academic year 2019/2020

Thesis title	Thematic field

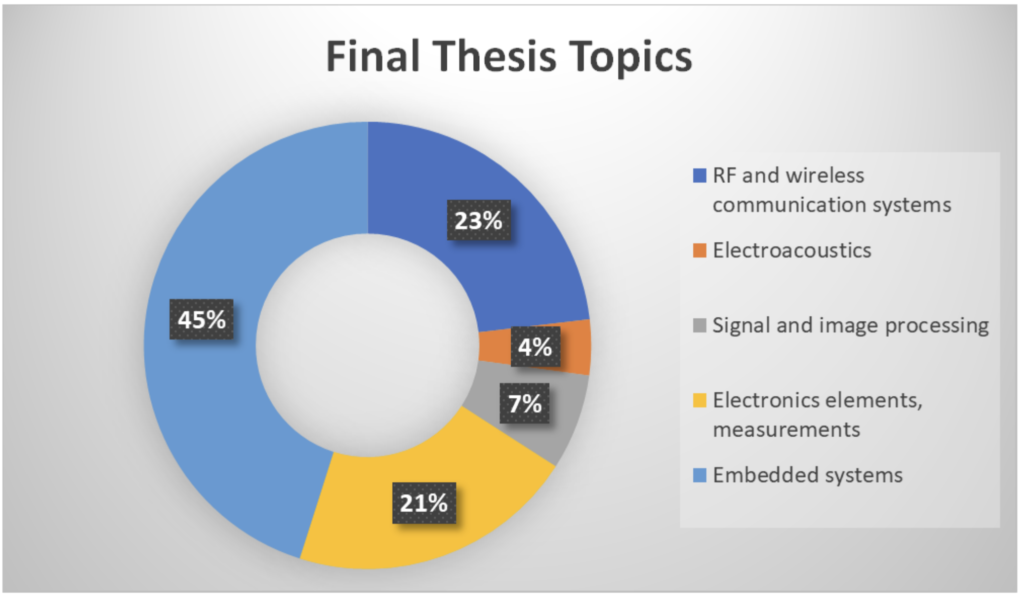
Calculation of the antenna amplifier	RF and wireless communication systems
Multi-band planar antenna	
Short-wave goniometer	
Short-wave broad-band receiver	
Measurement of the item temperature in an inductive oven	Electronics elements, measurements

Academic year 2020/2021	
Thesis title	**Thematic field**
Band filter for 5G telecommunications systems	RF and wireless communication systems
Passive system for identification of the radiowave emitter	
Ultra broadband impulse radio communication system based on the chaotic impulse position modulation	
Data string coincidence searching system	Signal and image processing
Effect of the spread spectrum method on the radiation caused by wireless energy transmission systems	Electronics elements, measurements
Clock and calibration signal generator	
Autonomous house heating controller	Embedded systems
Bit-coin miner design development in integral circuits	
Equipment for measuring parameters of the augmented reality head display optic system	
The detector of the brightest moments at competitions	
Use of synthetic data for robot training	
Device for blocking audio recording in a smartphone	

Analysis of the obtained data concludes that most graduation papers were devoted to developing and programming various types of embedded systems, electronics elements and measurements, and RF and wireless communication systems. In the year 2018 the content of the study program was substantially revised, and the title of the program was changed from "Electronics" to "Smart electronic systems". Improvement of the content of the study program was implemented with the active participation of the industry representatives resulting in the addition of study courses from the academic program "Electronics" (where enrolment of students was discontinued), which conform to two strategically selected perspective directions:

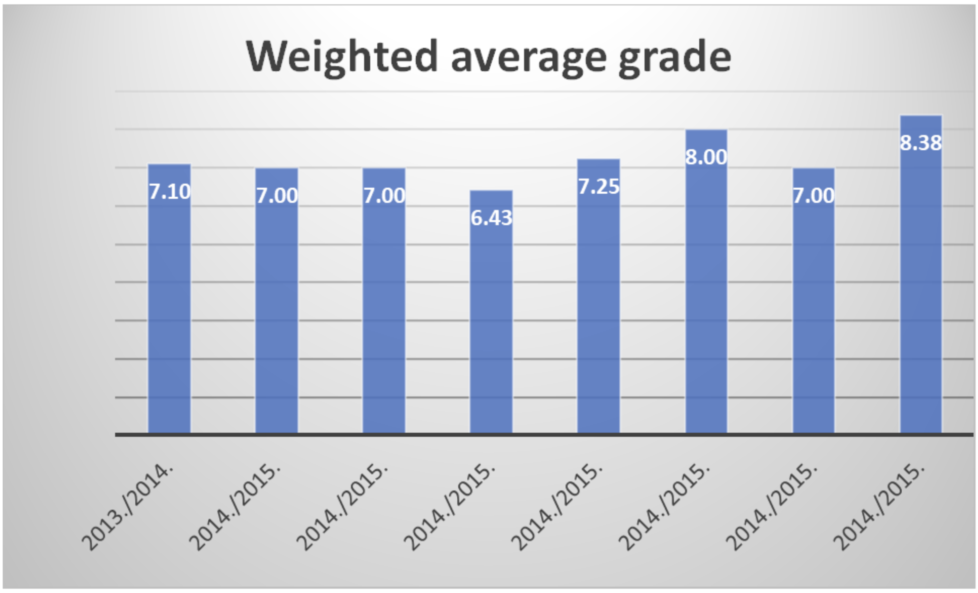
- ***Smart embedded systems***, which includes programming of microprocessors, programming of systems with reconfigurable logic gates, development of integrated circuits;
- ***Smart wireless communication systems, whoch*** includes 5G wireless technologies, data transmission on wireless sensor networks, software-defined radio systems, and microwave techniques.

The first graduates of the renewed study program are the graduates of the academic year 2020/2021 the topics of whose graduation papers also conform to the selected directions. It is expected that, in compliance with the needs of the industry, the graduates of the next year will continue developing the direction of embedded systems in their Master Thesis by focusing mainly on development of FPGA, SoC and ASIC, as well as more papers will be devoted to signal processing, as relevant study courses were included in the program and students have successful internships at the Institute of Electronics and Computer Sciences, where it is among the basic directions of activity.



Distribution of the topics of graduation papers

The graduation papers in the professional Master study program are evaluated by the state examination commission, where most members are the industry representatives with appropriate education levels. The weighted average grade for graduation papers has been around 7.3 (good) during the specified period, which attests to students' sufficient training and strict evaluation criteria applied by the commission.



The weighted average grade for graduation papers

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

All the available resources of the study program can be divided into centralised, for example, RTU Scientific Library and electronic database subscriptions; and the study program specific resources that supplement the centralised resources. Information about the library's resources and provision is provided in detail in section II of the self-assessment report. part 3, chapter 2.3.1.-2.3.3. in the criteria. This section describes the specific resources for implementing the professional Master study program "Smart electronic systems".

It is envisaged to implement the study program mainly on the RTU Faculty of Electronics and Telecommunications (ETF) premises. Renovation works were performed at ETF; therefore, the faculty conforms to international standards for providing a high-quality study process. Equipment of lecture rooms and training laboratories is continuously updated by following the industry development trends.

The teaching staff of ETF, in compliance with their specialisation is involved in implementation of study courses of the study program:

- Institute of Radioelectronics;
- Departments of Electronics Basics;

- Department of Electronic Devices;
- Department of Radio Devices.

Implementation of general education, humanities and the industry theoretical basic courses of the study program is provided by:

- Department of Labour and Civil Defence;
- Department of Languages of Special use.

Relevant structural units provide development and improvement of the materials of study courses, provision of lectures, supervision of laboratory assignments and practical classes and other study and methodological activities. The teaching staff of ETF is also in charge of supervision and public presentation of graduation papers and provision of Internships.

Also, the common RTU assistant staff is available to implement the study program and provide the functioning of the infrastructure. Implementation and maintenance of the study program are ensured by the administrative staff consisting of the study office administrator, records keeper and technical staff. Management of international students and coordination of the study work is done by the RTU International Cooperation and Foreign Students Department.

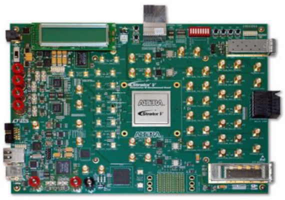
For the performance of laboratory assignments and practical assignments, ETF has access to specialised study laboratories with the modern equipment and software needed for mastering relevant practical skills within study courses. In addition to the basic study laboratories, students can also use the specialised laboratories located on the ETF premises:

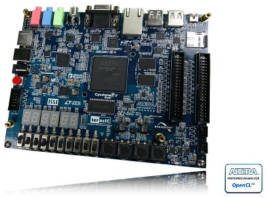
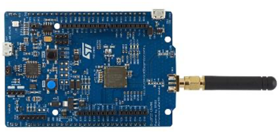
- Wireless sensor network and software-defined radio laboratory;
- Laboratory of Electroacoustics;

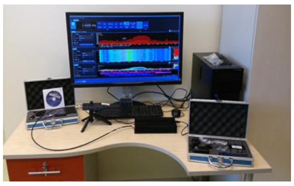
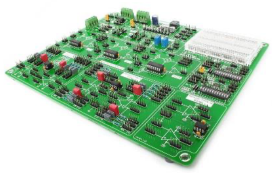
- Prototyping laboratory;
- Siemens IoT laboratory;
- Electronic devices testing centre of Latvia (LEITC);
- Electronics club.

During the period from 2013 to 2022, for the implementation of the study program "Smart electronic systems" of the study field " Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science ", as well as the performance of scientific and applied research minimum 67 computers and 6 projectors were procured. Many computers were provided with SSD disks, increased RAM and 8-16 cores to ensure implementation of the study courses related to simulation of electromagnetic fields, programming and simulation of embedded systems. The table presents examples of the specific equipment procured during the relevant period and split according to the core directions of the study program:

Figure	Description	Use
Smart embedded systems		

	ALTERA, DK-DEV-5ASTD5N,The Arria V SoC Develepment Kit development module. High- performance FPGA+SoC modules are used during studies and within the research process related to parallel processing a high volume of data. The kit is also used to develop course papers in the study course " Signal Processing in Heterogeneous Systems Containing FPGA " and the development of graduation papers.	Studies Research
	Development Kit, Stratix V Edition development module, Integrated circuits FPGA development kit. High-performance FPGA modules are used during studies and within the research process related to parallel processing a high volume of data. The kit is also used to develop course papers in the study course " Signal Processing in Heterogeneous Systems Containing FPGA " and in the development of graduation papers.	Studies Research
	XILINX, EK-Z7-ZC706-G, Xilinix Zynq- 7000 All Parogrammable SoC ZC706 Evaluation Kit development modules (2 pcs.). High-performance FPGA+SoC modules are used during studies and within the research process related to parallel processing a high volume of data. The set is also used to develop course papers in the study course " Signal Processing in Heterogeneous Systems Containing FPGA " and in the development of graduation papers.	Studies Research
	XILINX, EK-V7-VC707-G, Xilinix Virtex-7 FPGA VC707 Evaluation Kit development module, integral schemes (2 pcs.). High-performance FPGA+SoC modules are used during studies and within the research process related to parallel processing a high volume of data. The kit is also used to develop course papers in the	Studies Research
	study course "Signal Processing in Heterogeneous Systems Containing FPGA" and in the development of graduation papers.	
	Terasic Technologies P0150 Development Kit (10 pcs.). FPGA development sets are used for learning HDL software engineering language in the study course "Simulation of functional and logic circuits". The set is also used for the development of graduation papers.	Studies

	Altera DE1-SoC Board (10 pcs.). Development kits of integrated FGPA+SoC systems are used in the following study courses: “Simulation of functional and logic circuits”, “Signal Processing in Heterogeneous Systems Containing FPGA”.	Studies Research
Smart wireless communication systems		
	USRP B210 software-defined radio sets (10 pcs.) are used in the study course “Software-defined radio”, acquiring practical skills in the work with USRP equipment for signal generation, transmission, receiving and decoding.	Studies Research
	USRP N310 module with supply cables (Zynq-7100, 4 Channels,10 MHz-6GHz,10 GigE) with a power cord (2 pcs.). High- performance software-defined radio is offered to students to develop graduation papers in the Master study program and implement the project within the scope of the study course "Software-defined radio".	Studies Research
	Analog devices, AD-FMCOMMS5- EBZ,FMC module with dual AD9361 RFXCVR ICs development module (2 pcs.). The multifunctional RF module can be connected with FPGA development tools and applied to develop and test complicated programmable RF systems.	Studies Research
	Oscilloscope 20GHz 4 channels:72004C with options 72004C 5XL,72004CR3. A broad application oscilloscope of analogous and digital signals research is located in the "Wireless sensor network and software-defined radio" laboratory. It is available to students for developing graduation papers and scientific- research work. It can only be used following instructions and a training course.	Studies Research
	LoRa SODAQ Explorer kit (40 pcs.). Wireless sensor network units able to send data on LoRaWAN network. They are used in the study course "Data transmission in wireless sensor networks".	Studies
	STMLoRa Discovery Kit (20 pcs.). Wireless sensor network units able to send data on LoRaWAN network. They are used in the study course"Data transmission in wireless sensor networks".	Studies

	A Kerlink Wirnet iFemtoCell indoor LoRaWAN gateway (5 pcs.). Indoor LoRaWAN gateways provide comprehensive network coverage in the faculty and allow testing the solutions based on the LoRa technology and developed by students, as well as for implementation of scientific projects.	Studies Research
	Microwave technology experimental system WT- 9000- a part of the microwave laboratory equipment. It is used for demonstrations in the study course " Microwave Devices and Equipment" and the development of graduation papers and implementation of scientific work.	Studies Research
	Part of the microwave laboratory equipment - the loading set ZV-Z235E CALIBRATION KIT 3.5MM. It is used for the calibration of the vector network analyser. Scientific work, graduation papers on topics related to RF circuits and microwaves.	Studies Research
	Real time spectrum analyser Spectran V5 X (12GHz). The USB connected device is intended for the laboratory assignment "Data Transmission in Wireless Sensor Networks ", development of graduation papers and use in the study course "Software-defined radio".	Studies Research
	Analog System LabKitPro (10 pcs.). The set provides extensive possibilities for research of the analogous electronics components: comparators, operation amplifiers, multiplicators, supply sources, CAP and ACP, etc. It is used in the study course "Microelectronic Devices in Analogue Circuit Design " for practical assignments.	Studies
Equipment of broad application		
	Signal phase shift measuring device Keysight 53220A-1 pcs. It allows high accuracy measurement of shifts of two signals allowing research of signal delays in various electronic systems. It is used in the development of graduation papers and scientific work.	Studies Research

	Impedance analyser Keysight E4990A-120 with options 16047E and 16034H. The device is intended to survey the parameters of electronic components over an extensive frequency range. It is used for scientific work, development of graduation papers, as well as in the study course " Electromagnetic Compatibility of Radio Devices and Systems ".	Studies Research
	Soldering equipment ERSA PL IR 550, produced by ERSA, allows high accuracy SMD component placement and soldering. It is accessible for students at study programs of all levels to compose prototypes and soldering. It is also actively used in scientific work to develop the first device prototypes.	Studies Research
	PCB milling machine LPKF Protomat S103 (1 pcs.), manufactured by LPKF laser. The equipment provides extensive possibilities to implement high precision printed circuit boards (up to 2 layers, also RF) in the prototyping laboratory. It is used to develop graduation papers in "Design Technologies" study course. It is used to implement and survey the first prototypes in the research acctivities.	Studies Research

Some equipment is shared and used both in the professional Bachelor study program "Smart electronic systems", professional Master study program "Smart electronic systems" and in the PhD program "Electronics".

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU funding from the state budget consists of the funding based on the list of study programs and the number of students. It comprises funds for payment of utilities, taxes, maintenance of the infrastructure, procurement of inventory and equipment and staff wages, and funding for scientific activities.

The number of state budget funded seats is granted following negotiations with the Ministry of Education and Science. The study base funding from the state budget funds is allocated to full-time studies. The amount of the study base funding is defined based on the number of state budget funded seats at RTU defined by the state, the base costs of a study place defined by the state, and the rates of study costs of the thematic blocks of education. The rates of study costs of the thematic blocks of education are the indices defining the amount of costs of a study seat in the relevant thematic block of education in relation to the base costs of a study seat.

RTU has a decentralised budget. Therefore, each structural unit has its separate budget. In the general sense, the budget is a plan of revenues and expenditure for a particular period, assignment, event or function. In RTU, revenue and expense are managed according to the principles approved by the Senate or defined by the Vice-Rector for Finance according to his delegated authority.

Funding is allocated to structural units either in compliance with the fiscal or budget year or immediately following receipt of the funding. At RTU every head of a structural unit has remote access to actual financial information on a budget of the structural unit, including the scheduled workload and allocated funding in future periods for implementation of study programs and study courses. Based on this information, at the beginning of every fiscal or budget year, the head of a structural unit plans the activities of the structural unit, including wages for the teaching staff subordinated to the relevant structural unit head and develops a procurement plan for the next year for providing implementation of the study program or courses.

Funding obtained in the program is used to cover daily expenses related to the implementation of the study program (for example, premises, utility payments, etc.). After making the mandatory payments, the remaining funding is used for the development of the study program: literature relevant to the content of the study program is purchased (for Latvian and international students), the existing stock of electronic components is maintained and replenished, new modern development kits for practical lessons are purchased (e.g., microcontroller programming, data transmission systems etc.).

The state budget funded seats in the professional Master study program "Smart electronic systems" are continuously filled, attesting to the quality and financial self-sufficiency of the study program. The primary sources of funds for the provision of the program per year are presented in detail in the table below:

Study year	Grant for the program, EUR	Tuition fee in the program, EUR		Total funding for the program, EUR	Funding for one state budget funded seat, EUR
		Tuition fees for local students, EUR	Tuition fees for foreign students, EUR		
2013/2014	117,109.00	-	-	117,109.00	5,799.00
2014/2015	122,054.79	1,323.28	-	123,378.07	5,799.00
2015/2016	60,634.17	-	-	60,634.17	5,799.00
2016/2017	66,752.83	3,510.00	-	70,262.83	5,799.00
2017/2018	64,669.20	1,650.00	-	66,319.20	6,060.99
2018/2019	71,342.68	880.00	18,837.64	91060.32	6,344.52
2019/2020	133,189.88	-	96,758.48	229,948.36	6,607.56

2020/2021	172,039.45	-	108,226.16	280,265.61	6,694.22

Note: The professional Master study program "Smart electronic systems" was developed based on the professional Master study program "Electronics", which was revised and renamed in 2018.

The analysis of the financial data confirms that there was a rapid decrease in funding starting from 2015 when the interest in the study program decreased. To promote the development of the study program, its content was revised in compliance with the industry trends, and also the title of the program was changed. International students are admitted to the renewed program as from 2018. The data presented in the table clearly show that the above measures contributed to a rapid increase of funding, which took place on account of the increase in the number of foreign students from 2018 and the grants. During the last few years the interest in the study program has been steadily increasing, which is also reflected in the relevant increase in the funding.

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "Funding distribution between the cost items"

Information on the minimum needed number of students in the program is presented in the annex to the self-assessment report "On minimal number of students in study programs".

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The teaching staff of various levels and professional qualifications are involved in implementing the study program to achieve the high-quality provision of the study courses included in the program. The following teaching staff is involved in implementing of the study program: 3 Assoc. professors, 5 Assistant professors, 4 lecturers, and 1 assistant, of whom 6 have the PhD degree and 2 are PhD applicants whose PhD Thesis are scheduled for defence in 2022. The average age of the teaching staff is 48 years. The composition and split of the teaching staff in 2022 are presented in the table of Section 3.4.2. The qualification of the teaching staff implementing the study courses of the program conforms to the requirements of the implementation of the program. All the involved teaching staff members are elected teaching staff in compliance with the requirements of RTU. 80% of the personnel are actively involved in the research activities and scientific projects of the Institute, research contract works, and hold elected scientific positions. During the reporting period, 13 new teaching staff members have joined the program by providing provision of the program's existing and new study courses and supplementing the range of research fields and the list of possible topics for graduation papers. Thus, most of the staff have experience working in the industry and research, which is reflected in the staff CV's. The teaching staff involved in the study process effectively provide the study courses of the professional study program. This has resulted in the increase of applicants and graduates (local and foreign students).

In compliance with the objectives of the study program, the primary criteria for the selection of personnel are as follows:

- Master or PhD degree in engineering;
- work experience in the industry, in a relevant field;
- experience in providing study courses;
- experience in scientific activity, including participation in scientific projects and a number of publications;
- knowledge in the field of technologies related to modern electronics;
- compliant knowledge of Latvian and English.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, the number of the teaching staff in the study program increased considerably by more than a half. It could be explained by the changes in the study program during the improvement process, including addition of new study courses, and the personnel change. It should be noted that the number of students in the program increased considerably after changes were implemented in the study program, which, in turn, substantiates the increase in the teaching staff. In 2013 the study program was provided by 6 teaching staff members: 2 professors and 4 assistant professors/ acting assistant professors, of whom 5 had a scientific degree. The mean age was 68 years. 14 teaching staff members are involved in the provision of the program in 2022: 3 assoc. professors, 7 assistant professors, 3 lecturers, and 1 assistant, of whom 6 have the PhD scientific degree and 2 are PhD applicants whose PhD Thesis are scheduled for defence in 2022. The mean age is 48 years.

As the generation change took place, 14 new teaching staff members possessing experience in both working in the industry and the scientific work were involved in the implementation of the program. Experience in the industry improves the quality of provision and content of the professional Master study courses. The experience in the scientific research work improves the professional level and competence of the teaching staff by ensuring the application of the scientific approach in the solution of complicated tasks and educating students. The personnel involved in the provision of the study program actively participates in implementing research projects as supervisors, leading researchers or researchers. Approximately 80% of the teaching staff are elected to scientific positions. It should also be noted that the number of research projects at the Institute of Radioelectronics and the staff's involvement in them have increased considerably during the last three years.

Distribution of the teaching staff in 2022

No.	Name, surname	Full years	Scientific degree	Position	Elected academic position	Elected scientific position

1	Aišpurs Vitālijs	69	none	Assistant professor (practical), researcher	07.06.2024.	23.01.2023.
2	Āboltiņš Artūrs	48	Dr.sc.ing.	Assoc. prof., Leading researcher	27.09.2023.	14.07.2027.
3	Igaunis Andris	33	none	Assistant professor (practical),	29.04.2025.	-
4	Kušņins Romāns	36	none	Lecturer, researcher	18.02.2025	21.12.2023.
5	Litviņenko Anna	36	Dr.sc.ing.	Assoc. Prof., leading researcher	07.04.2026.	21.12.2023.
6	Pētersons Leonīds	81	none	Assistant professor	29.03.2028.	-
7	Pikuļins Dmitrijs	37	Dr.sc.ing.	Assoc. prof., Leading researcher	06.02.2023.	25.05.2025.
8	Pudžs Mihails	36	none	Lecturer, researcher	07.06.2024.	06.03.2023.
9	Semeņako Jānis	75	Dr.sc.ing.	Assistant professor, leading researcher	07.06.2024.	20.06.2027.
10	Solovjova Tatjana	44	none	Lecturer, researcher	06.03.2023.	12.05.2028.
11	Šīrs Juris	58	none	Assistant professor (practical)	23.03.2028.	-
12	Tērauds Māris	41	Dr.sc.ing.	Assistant professor, leading researcher	17.06.2026.	20.05.2025.
13	Zeltiņš Māris	58	Dr.sc.ing.	Assistant professor, researcher	15.06.2023.	06.03.2023.
14	Kolosovs Denis	32	none	Assistant, researcher	25.01.2027.	29.03.2028.

Distribution of the teaching staff in 2013

No.	Name, surname	Full years	Scientific degree	Position
1	Balodis Guntars	63	Dr.sc.ing.	Professor

2	Fiļipovs Aleksandrs	69	none	Acting Assistant professor
3	Ņikitins Vadims	74	Dr.sc.ing.	Assistant professor
4	Slaidiņš Ilmārs	65	Dr.sc.ing.	Professor, researcher
5	Tomariņš Kārlis	90	Dr.sc.ing.	Assistant professor
6	Zeltiņš Māris	49	Dr.sc.ing.	Assistant professor

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

There is active cooperation of the teaching staff on various levels by using various communication channels. Professional study courses, teaching materials, the study program, development strategy and the sustainability plan are continuously updated, supplemented and improved. Also, new study courses are either created or added considering the sequence of study courses. Improvements are based on the scientific activity of the teaching staff, analysis of the current trends, incorporation of changes from the RTU strategy, and following the industry development trends. The study process is also being adopted at various levels of change: global, national, university, and faculty. Amendments of the national laws related to the organisation of the study process, the RTU internal orders for providing the study process, changes in the development strategy of RTU and the faculty, the industry development trends on the national, European and global levels are followed. The students' opinions regarding the quality of the materials of study courses and teaching, regular surveys and meetings with the faculty management are also considered. Also, references by the industry, in the students' internship assessments and requirements to the industry experts presented at the meetings of the Latvian Electrical Engineering and Electronics Industry Association (LETERA), job advertisements and the profession standard are taken into account.

Various communication channels are used to ensure cooperation:

- In-person and remote meetings on the level of the Institute of Radioelectronics - improvement of the development strategy and the sustainability plan, updating of the study program, discussions and adjustments of the study plans, analysis of students' progress, improvement and sequence of study courses, development of new courses, discussion of the themes of qualification papers, an adaptation of the study process to various changes.
- In-person and remote meetings on the level of departments - for the planning of the academic year/ half a year, discussion of changes of the study process in the circumstances of COVID pandemic, approval of the topics of qualification papers, coordination of the teaching of study courses, approval of individual internship programs.
- In-person and remote meetings on the level of individual sub-fields - for improvement of study courses and continuity, development of new courses, motivation of students, involvement of students in scientific or study process.
- Meetings of heads of departments - for discussion of strategic and essential issues and agreement thereof.
- E-mail - for disseminating orders related to the study process, announcing various events, and sharing other current information.

- Seminars and open lectures devoted to the teaching work on the level of the Iinstitute of Radioelectronics and the faculty.
- Social networks, like Facebook, Instagram - for the announcement of various events.
- Messengers, for example, WhatsApp groups on the level of the institute and the faculty - for discussing important and urgent issues and sharing information.
- Cloud storage, like Onedrive, GoogleDocs, Microsoft Teams - for the development of joint documents and materials, storage and shared access.
- ORTUS - the uniform RTU system for sharing and storing of descriptions and materials of study courses, provision of the study process, distribution of results of scientific activity, storing and sharing of graduation projects, the announcement of news and events, surveys of students regarding the quality of provision of study courses - used for the provision of the study processes on a daily basis.

- Special social networks ResearchGate, Linkedin - for publishing professional and scientific achievements and ensuring their accessibility.
- Special databases, like Scopus, IEEExplorer - for dissemination of the scientific activities.

At present 57 students studying in the professional Master study program "Smart Electronic Systems" and 14 teaching staff members are involved in the implementation of the study process. As a result of the active cooperation of the teaching staff, the provision and improvement of the study program are implemented continuously and effectively.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_EGV0(47523)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_EGV0(47523)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EGV0(47523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EGV0(47523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_EGV0(47523)_Compliance with the state education standard _ProfMag_EN.pdf	P06_3.2.1_EGV0(47523)_AtbilstibaValstsStandartam_ProfMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_EGV0(47523)_Compliance with the professional standard_Prof.Mag._EN.pdf	P07_3.2.1_EGV0(47523)_AtbilstībaProfesStandartam_Prof.Mag..pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EGV0(47523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EGV0(47523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EGV(47523)_Plan_eng.zip	P09_3.2.1_EGV(47523)_Plans_lv.zip
Descriptions of the study courses/ modules	A10_EGV0(47523)_StudyCoursesdescr_ENG.zip	P10_EGV0(47523)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_EGV0(47523)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_EGV0(47523)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Information Technology (43526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Information Technology*
Education classification code	*43526*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Janis*
Surname of the study programme director	*Grabis*
E-mail of the study programme director	*grabis@rtu.lv*
Title of the study programme director	*Dr. sc.ing.*
Phone of the study programme director	*67089594*
Goal of the study programme	*To educate professionals with higher education in information technology who are able to function as a user advocate and select, create, apply, integrate and administer computing technologies to meet the needs of users within a societal and organizational context*
Tasks of the study programme	*• To provide the comprehensive engineering education and indepth knowledge in information technology; • To prepare students for successful professional career and to train professionals requested by industry; • To develop individual talents of students and to provide stimulating studying experience and environment; • To nurture recognition of the need for and an ability to engage in continuing professional development; • To foster research and development activities and to promote academia and industry collaboration; • To promote critical and systems thinking and to develop collaboration and cooperation skills; • To develop academic potential of the faculty members and to ensure efficient use of resources; • To explain and to promote information technology in the society.*

Results of the study programme	*• An ability to use engineering principles and methods in information technology; • An ability to explain theoretical foundations of information technology including theory of algorithms, data structures, discrete mathematics, theory of systems and computer architecture; • An ability to use information technologies in development of computing systems including computer networks, data bases and software applications, at organizations and enterprises; • An ability to plan and to operate information technologies at enterprises; • An ability to develop and to analyze models of systems; • An ability to structure and to analyze large data sets; • An ability to integrate systems and to implement business applications; • An ability to communicate with information technology customers and to justify usage of information technologies; • An ability to participate in projects and to perform research in information technology*
Final examination upon the completion of the study programme	*Writing and defense of the Bachelor Thesis including a test of knowledge in fundamental areas of information technology.*

Study programme forms

Full time studies - 3 years - latvian

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*120*
Admission requirements (in English)	*General or Vocational Secondary Education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor of Engineering Sciences in Information Technology*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The classification code of the study program has been changed. During the previous accreditation period, the study program code was 43481, which represented the group of educational programs in Computer Science in the thematic group Natural Sciences, Mathematics and Information Technologies. The change of the code was made pursuant to Cabinet Regulation No 322 of 13 June, 2017.

The most relevant code for the study program is 43526 – educational program group “Other engineering sciences” in the thematic field “Engineering Science and Technology”. Engineering sciences and technologies is the strategic field of specialization of Riga Technical University and the organizational unit in charge of the study program implementation works in the scientific field of Electrical Engineering, Electronics, Information and Communication Technology. The study program is designed according to the uniform RTU requirements for study programs[1] that prescribes integration of engineering science related study courses into compulsory study courses. Those include the study courses in mathematics and physics. The study program also includes specific IT study courses, that comprise study courses in Computer Architecture, Computer Networks, Computer Aided Control, System Modelling and Design. The main objective of the study program in IT is to ensure development of IT solutions for practical and business applications that fall within the nature of engineering sciences, and those topics are considered in detail in the specialization study courses. The degree awarded is also changed accordingly to Bachelor of Engineering Sciences in Information Technology.

The overall stdy load has been changed from 122 CP to 120 CP as required by the regulations that one year of studies is 40 CP. The course of General Chemistry (2 CP) was excluded from the study program according to changes to the uniform RTU requirements for study programs.

[1] https://www.rtu.lv/writable/public_files/RTU_studiju_reglaments_4.4._vienotas_prasibas_studiju_programmam_2020.03.30.pdf

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program is implemented in the field “Information Technologies, Computer Technology, Electronics, Telecommunications, Computer Control and Computer Science”, because according to recommendations of ACM/IEEE “A Report in the Computing Curricula Series”, it is one of the base programs in Computer Science and Information Technology.

The title of the study program precisely characterizes the study field, the goal and the outcomes of the study program. Graduates of the study program work as IT specialists. The code of the study program is 43526 in the group of study programs “Other Engineering Sciences” of the field Engineering Science and Technology. Information technology refers to the field of Engineering Science and Technology[1], it was designed according to the strategic specialization of Riga Technical University in Engineering Science and Technology and its curriculum is focused on the development of IT solutions for on-the-job applications in companies and organizations.

According to the field of study, the awarded degree is Bachelor of Engineering Sciences in Information Technology. The awarded degree characterizes the Faculty’s activities in the research field of Electrical Engineering, Electronics, Information and Communication Technology.

To provide comprehensive education in engineering and information technology, the learning outcomes imply joint acquisition of the principles and theoretical foundations of engineering, theoretical foundations of computer science, specific aspects of information technology, as well as training and development of research skills in information technology.

The workload of the study program is 120 CP (reduced from 122 CP) and its duration is 3 years, which is in compliance with Cabinet Regulations No.240 of 13 May, 2014 “Regulations on the State Academic Education Standard”. Such duration and workload of the program offers young specialists the necessary knowledge and skills at undergraduate level and allows young IT professionals to take up faster employment in the profession, which is especially valuable taking into account high demand for IT specialists in Latvia and in the world.

The study results represent a sequential evolution of students both academically and professionally. The first three study results concern engineering and fundamental aspects. These provide foundation for study program specific study results (4 to 6). The seventh to ninth study results represent a synthesis of the knowledge gained for its successful application in practice and research.

Secondary school graduates are entitled to enter the program through public competition for enrolment. The competition is organized based on RTU Senate approved rules “Admission Rules for Academic and Professional Bachelor Programs”. The competition takes into account the grades in mathematics and physics, or a foreign language, which lie at the heart of successful IT studies. Knowledge in mathematics and physics is vitally important in acquisition of the corresponding university study courses, knowledge enhancement and accumulation, as well as achievement of the learning outcomes in algorithmization, data structures, discrete mathematics, theory of systems, computer architecture, computer networking, and database and software development, and other fields.

[1] https://likumi.lv/ta/id/296661-noteikumi-par-latvijas-zinatnes-nozarem-un-apaksnozarem (only in Latvian)

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Information technology is one of the most significant and fastest growing sectors of the Latvian economy, which constantly needs young specialists. IT specialists are characterized with high social mobility, and the sector provides essential input for regional development.

Graduates of the study program work for IT companies in Latvia and globally, as well as for the companies that apply complex IT solutions. The major employers are “Accenture”, “Tieto”, “Latvenergo”, “TET”, “ZZ Dats”, “Luminor”, “Visma”, " Wonderland Media”, “Squalio Cloud Consulting”, “Ernst & Young”, “Latvijas Mobilais Telefons”, “C.T.Co”, “Scandiweb”, etc.

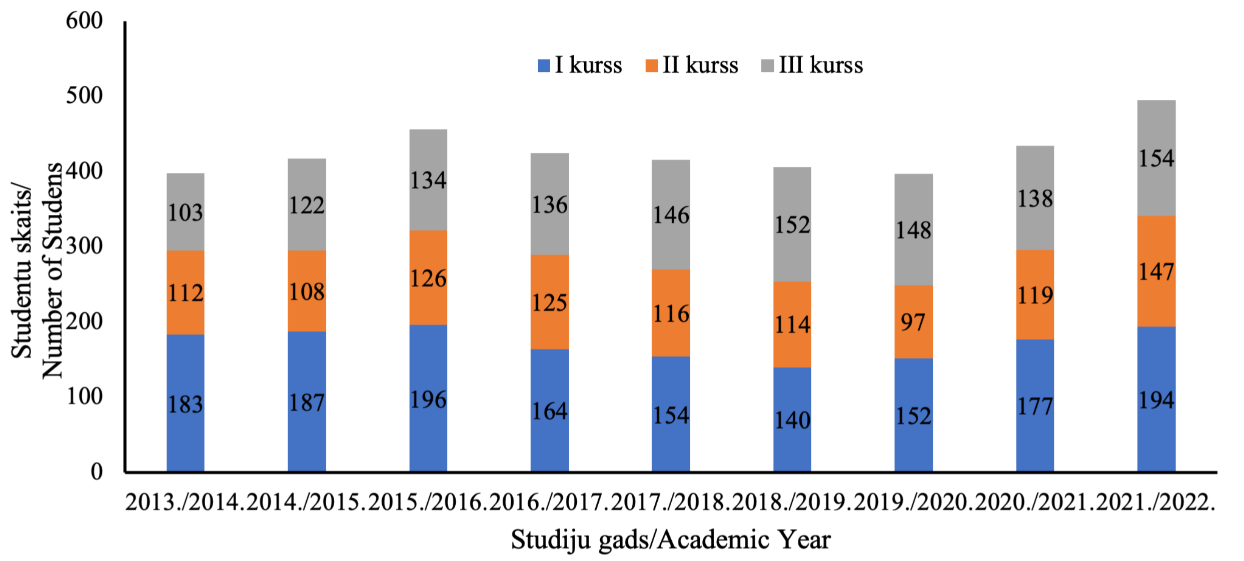
Graduates work as IT consultants, developers of application software, software developers, system analysts, system administrators, testers and other IT professionals. ICT sector is a high added value sector. Its professionals earn 60% greater salary than the average salary in the country, and it is the second in the list of best paying sectors (https://stat.gov.lv/lv/statistikas-temas/darbs/alga/preses-relizes/6568-darba-samaksa-2020-gada). The sector makes a substantial contribution to the Latvian economy, producing 5% of the total national value added. (https://lddk.lv/wp-content/uploads/2020/06/zinojums_ts_062018.pdf).

Unemployment ratio among program graduates is very low. Only 1.4% of the total number of graduates are unemployed, but 7.4% are economically inactive for various reasons (statistical data for 2017-2018 on employment ratio among graduates of the Latvian higher education establishments). The STEM sector is expected to experience shortage of workforce in 2027 – 14,000 specialists, which means that graduates of the study program are vitally important for the national development and in the longer term they have good employment opportunities (https://likumi.lv/ta/id/324332-par-izglitibas-attistibas-pamatnostadnem-2021-2027-gadam).

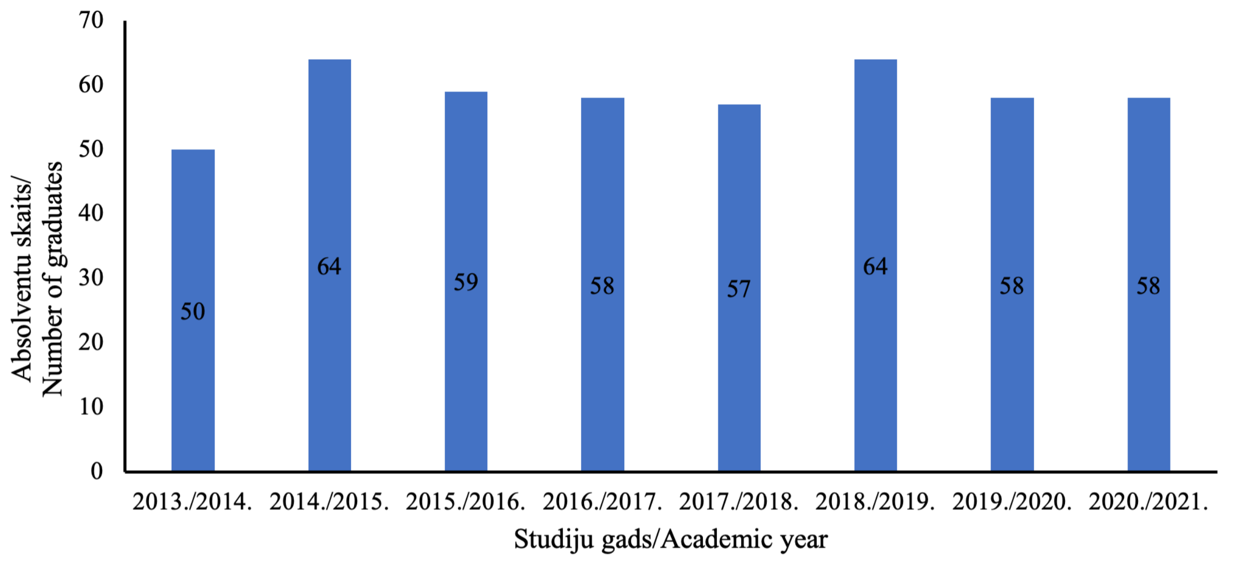
3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

During the reporting period, the Bachelor study program “Information technology” was delivered in Latvian in full-time mode. The study program enrolls an average of 150 students. This number has increased over the past two years both as the result of promotional activities on the study program and of COVID-19 pandemic. The number of students is optimal, which ensures effective use of resources and does not cause deterioration of the quality of studies, as well as meets the existing capacity of the physical infrastructure of the university. The number of second-year students decreased because of expulsion rates. During the first year of studies, around 30% of students are expelled, which is a high ratio. This depends on the level of pre-existing knowledge of students, and results of centralized secondary education exams do not always reflect precisely the students’ level of preparedness. The study program is considering options to raise the admission requirements that would reduce the number of enrolled students but would affect high demand for IT specialists in the field. To train students better for enrollment in RTU, engagement the talent program has been established in order to engage students with excellent outcomes, and their engagement will also help in future raise the general level of studies.

Academic failure is the most significant reason for expulsion (80%). During the second year of studies the drop-out ratio decreases significantly. During the third year the number of students increases, because students who did not finish writing their graduation papers re-enroll.



The average number of program graduates is 55-60, and this number remained unchained during the reporting period. The decrease in the number of graduates is greatly influenced by the number of students who do not finish writing their graduation papers. Successful development of graduation papers often depends on the fact that students early (at the end of second year or at the beginning of third year of studies) take up an employment and cannot devote the time required for development of a graduation paper. To promote timely writing of graduation papers, the study program has updated the methodological guidelines for development of graduation papers, has changed the graduation paper development time schedule, as well as the appropriate supervision and support activities.



3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The study program consists of compulsory study courses (86 CP), compulsory elective study courses (20 CP), free elective study courses (4 CP) and graduation paper (10 CP). The compulsory study courses include the courses covering industry guidelines, principles, structure and methodology (25 CP), study courses devoted to the history of the field development and relevant problems (10 CP) and study courses devoted to characterization and intersectoral issues of the sector (15 CP), which correspond to joint requirements of Riga Technical University towards the study programs. Compulsory elective study courses include professional specialization study courses (15 CP), study courses in humanities and social sciences (2 CP) and languages (3 CP). Professional specialization study courses cover the fields specific for IT study program and sector: IT management, modelling and design of complex systems, data analytics and IT applications. The courses in humanities and social science with compulsory study course SDD701 Innovative Product Development and Entrepreneurship ensure comprehensive education and training for careers in social and organizational contexts. The compulsory part also includes study courses ICA301 Civil Defence and VAS038 Environment and Climate Roadmap, teaching students to use information technologies responsibly and sustainably. Free elective study courses let students acquire knowledge and skills in the fields of their interest both in the IT sphere and in other industries. A graduation paper is a research paper with the elements of scientific approach on an individually given topic, it is followed by a final examination, which summarizes and evaluates the acquired knowledge showing final learning outcomes and how much a student fulfils the degree requirements in IT. Such structure of the study program ensures achievement of the study program's objective – education and training of qualified specialists with higher education in IT, capable to choose, develop, integrate, apply, introduce and maintain user-friendly IT solutions when solving business problems at companies and organizations.

For acquisition of the foundations of engineering, the study program includes Mathematics (9 CP) and Physics (6 CP). This knowledge is strengthened and advanced with help of study courses in analytical methods and discrete mathematics (15 CP) (DIM707 Discrete Mathematics, DOP204 Numerical Methods, DMS212 Probability Theory and Mathematical Statistics, DSP202 Discrete Structures of Computer Science, DOP201 Introduction to Operations Research and DMS214 Random Processes). The basis of specific IT knowledge is programming and algorithmization (14 CP) (DIP107 Algorithmization and Programming of Solutions, DIP203 Data Structures, DIP208 Programming Languages, DPI230 Object-Oriented Programming). Computer engineering and systems are covered by study courses in the workload of 12 CP (DST203 Introduction to Computer Architecture, DIP381 Operating Systems, DOP319 Computer Networks, DDI711 Basics of Computer Control). Data processing and information systems are addressed within DSP201 Database Management Systems and DMI738 Introduction to Data Management and Mining (7 CP). Modelling of complex systems is acquired within DMI201 Fundamentals of Computer Simulation and Modelling and DMI305 Systems Simulation Tools (6 CP).

During the third year of studies, at the compulsory elective courses students increase the knowledge and skills acquired in compulsory study courses in IT management, complex system modelling and design, data analytics and IT applications. Application development and research skills are trained in DOP719 Design Laboratory, DOP720 Data Integration and Cloud Computing Seminar and DMI739 Engineering Solutions for Virtual Computing and Simulation Technology Integration (seminar). IT management is considered in DOP390 Introduction to Project Management, DOP391 Information Systems Management and DMI756 Fundamentals of Cybersecurity. Methods of information systems and data analytics are thoroughly acquired in DSP303 Technology of Large Database, DMI737 Decision Analysis Techniques and DID306 Introduction to Genetic Algorithms. IT technology applications are studied in DMI374 The Fundamentals of Logistics Information Systems and DOP718 Enterprise Applications. The knowledge acquired at these study courses allows achieving specific learning outcomes of the study program.

The table below summarizes data from the mapping among the course level study results and the program' study results about contribution of the study courses to the overall study results. The contribution corresponds to the sequential learning principle, where the first two years are devoted to engineering and fundamental information technology subjects (first three study results). Specialization courses like DOP718, DOP720 and DOP319 also contribute to solidify the knowledge. The specialization courses provide main contribution towards achieving the study program specific study results (fourth to sixth study results). The third year study courses jointly with humanities, social sciences and environment protection courses as well as Bachelor Thesis (DOP001) integrate and strengthen knowledge attained for its successful application in development of complex systems, practice and research (seventh to ninth study results).

Study program study results								
1	2	3	4	5	6	7	8	9

DID305	DAA300	DID306	DMI756	DID305	DMI737	DDI711	DMI305	DID306
DIM701	DDI711	DIP208	DOP391	DIM701	DMI738	DID306	DMI737	DMI374
DMI305	DID306	DIP225	DOP718	DMI201	DOP719	DIP381	DMI739	DMI739
DMI739	DIM707	DOP390	DOP721	DMI305	DOP720	DMI374	DMI756	DMS212
DMS212	DIP107	DOP718		DMI737	DSP303	DMI702	DOP390	DOP001
DMS214	DIP203	DOP719		DMI739		DMI739	DOP719	DOP201
DOP204	DIP208	DOP721		DMS212		DMI756	DOP720	DOP204
DOP720	DIP381	DPI230		DMS214		DOP319	DOP721	DOP390
DSP105	DMI201	DSP201		DOP201		DOP390	HSP379	DOP391
ICA301	DMI374	DSP303		DOP204		DOP391	HSP380	DOP719
MFZ101	DMI737	DDI711		DOP719		DOP718	HVD149	DOP720
SDD701	DMI739	DIP381		DSP202		DOP719	HVD153	DOP721
VAS038	DMI756	DOP319				DOP720	ICA301	DSP202
	DOP201	SDD701				DOP721	SDD701	DST203
	DOP204					DSP303	VAS038	HVD149
	DOP319					ICA301	XHSP378	HVD153
	DOP390					SDD701		ICA301
	DOP718					VAS038		MFZ101
	DPI230							SDD701
	DSP201							VAS038
	DSP202							XHSP378
	DSP332							
	DST203							
	MFZ101							

Recent trends in IT technologies include digital transformations, Big Data technologies and applications of artificial intelligence, cloud computing, cybersecurity and merging of digital and virtual space (i.e., digital twins and extended reality). Compliance of the study courses to the trends in the labor market and knowledge development is ensured through improvement of the study courses, selection of topics for research papers and changes to the study program. Issues of cybersecurity are considered within study course DOP319 Computer Networks, but, taking into account rapidly growing significance of the topic, in 2021, a specific study course on the fundamentals of cybersecurity was launched, which in addition trains students for further Master degree studies. In 2022, the study course Fundamentals of E-commerce was renewed within the program (has not been offered since 2018), its curriculum will follow the trends in modern e-commerce and digital transformation. In 2022, a very relevant course nowadays DID305 Introduction to Artificial Neural Networks has been included in the compulsory elective part. Previously, it was a free elective study course.

Research project topics of study courses DOP719 Design Laboratory and seminars are selected in cooperation with companies or the themes relevant within research projects implemented by the department. The issues to be solved in academic year 2021/2022 have been delivery route planning (optimization), prediction of basketball scores (data analytics), planning of printing jobs (optimization), system of the university indoor air quality monitoring (IoT and data analytics), fisherman registration (machine learning) and planning of balanced diet (optimization and data analytics), and the papers make an accent on the use of intellectual opportunities in IT solutions. The issues discussed within DOP720 include system integration and cloud computing included prediction of railway level crossing closing time (machine learning and web programming), integration and visualization of WAZE problem reports (web programming, development of mobile applications, GIS), identification of transhipped lorries (computer vision and web programming), prediction of bus arrival time (machine learning and web programming), counting of traffic objects (computer vision and web programming), and the topics were formulated together with such organizations as Latvian Railways, Latvian Road Maintenance, "Rīgas satiksme" Management Centre, CATA.

Updating of the curriculum of the study courses is carried out according to RTU regulations. If essential changes have been made to the content, they are considered by the Committee in the field of "Information Technologies, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science", which also involves representatives of the industry. Operational changes are made when elaborating a calendar plan for the next academic term according to RTU regulations concerning the use of the e-learning environment. Methodological Committee of FCSIT considers the relevant issues. For example, during the reporting period, changes have been made to delivery of the study course in programming, shifting to the programming language and development media that comply with the industry's requirements, the guidelines on graduation paper development have been updated and supplemented (unified guidelines for Bachelor paper development at the academic study programs of RTU Faculty of Computer Science and Information Technology). At the faculty seminar for the academic staff, issues of study process digitalization, application of modern teaching methods, evaluation of learning outcomes and academic integrity are discussed.

Trends in the industry help involve large IT companies in academic partner programs, which allows using the latest software and guidance materials. The study program in IT technology uses materials from "Microsoft Academic Alliance", "SAP University Alliance" and "Tableau". For example, in 2020 the curriculum of the study course DOP718 Enterprise Applications was radically changed, shifting from the self-hosted "Dynamics AX" system to a new cloud-based computing system, provided by "Microsoft Academic Alliance".

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

A didactic approach used in the study program is based on building of initial fundamental knowledge and skills, which is followed by advancement and practical application thereof in project-oriented study courses. It implies development of curriculum and organization of studies, which ensures consistent and in-depth acquisition of knowledge delivered within the study program and is oriented towards practical problem solving.

The study program offers full-time studies in Latvian, complying with the requirements stipulated by regulations, and basic principles of organization of studies at RTU and fulfilling the requirements of the study courses. Descriptions of the study courses of the program specify the corresponding body of knowledge, skills and competences, and their evaluation system, define learning outcomes to receive credit points. The assessment procedure for students' knowledge, skills and competences is specified in the decision of RTU Senate of 27 May, 2017 "On the Regulation on the Assessment of Learning Outcomes" that is in compliance with the basic principles and procedure of education assessment defined by Cabinet regulations in the relevant education cycle. Summative assessment is used in the assessment of learning outcomes, when the final grade consists of several components. Full-time studies imply acquisition of 40 CP per academic year and the workload of 40 hours of studying per study week, which makes 1 CP. Within the Bachelor studies, 50% of the workload is taken by contact hours and 50% is individual work (self-education).

Delivering the study courses, academic staff select a didactic approach appropriate for a topic, coordinating the distribution of study loads, learning outcome assessment methods and basic organizational issues of the study courses, i.e., individual or group work, at the level of the study program. Normally, contact hours for lectures and classes in the study program are evenly distributed. Classes usually take place in small groups in a computer classroom. Regarding the academic issues, individual approach is ensured according to the methodology approved by RTU Rector order "On the Guidelines for Planning the Work of Academic Staff", which specifies that the academic staff must provide consultations for each group of 25 students (duration of the consultations is 15% of total lecture hours). In addition, individual consultation hours are planned for supervision of study papers and projects, internship reports and graduation papers. Pre-examination consultations are organized before exams. In necessary, students can apply directly to the academic staff members outside consultation hours, by sending relevant questions either as a message, or in a corresponding study course forum in ORTUS system, or by email.

To advance student technical skills and better integrate general and industry specific study courses, information technologies are also use within the general study courses, i.e., in the study course in Mathematics, a part of practical classes includes "MatLab" based programming, but at the Introduction to Operations Research, students acquire the basics of declarative programming, which is not discussed within the study courses in programming.

At the lectures, when discussing theoretical questions, programming tasks are addressed jointly, for example, within the study course Object-Oriented Programming, where lectures are recorded as programs, similar to the study course CS50 at Harvard University. During the 2nd and 3rd years of studies, students can choose independently a language of programming for problem solving, for example, at the study courses Introduction to Operations Research and Introduction to Data Management and Mining. This simultaneously allows students to build their knowledge in the development environment of their interest/language of programming or also learn new languages of programming to solve new tasks. During the lectures, especially during online lectures, mutual assistance opportunities of students are used, when students form pools and clarify one another solution of the tasks.

Digital laboratories are used both in general study courses (Physics) and specialized study courses (Information Systems Management). Within the study course Information Systems Management, students develop, manage, supervise and protect a company's IT infrastructure in a virtualized environment, and automated scripts are used to check efficiency of security and management activities. Opportunities of automated testing and reception of immediate feedback are also used at the study course Programming.

The study program Information Technologies applies the project-oriented approach within the courses DOP719 Design Laboratory, SDD701 Innovative Product Development and Entrepreneurship, DOP720 Data Integration and Cloud Computing Seminar and DMI739 Engineering solutions for Virtual Computing and Simulation Technology Integration (seminar), where students develop projects on important industry-related and scientific issues in groups. For DOP512 Enterprise Application Integration, initial academic achievements or failures in the practical part of the paper are assessed using the four eyes principle, whereas quick feedback lets reasonably identify a problem, which is reviewed at the beginning of next practical class.

The study program uses the Moodle-based RTU interactive e-learning environment on the web portal www.ortus.rtu.lv, which is regularly used by the study program students, academic staff and visiting lecturers. On the portal, students have access to all relevant information throughout their studies. It hosts relevant study courses (abstracts, requirements to successful acquisition of the study course, lecture syllabi, lecture notes and practical exercise, mandatory literature and other information materials), information on a student's achievements and acquired study courses, the latest news, library information, access to learning and scientific literature and databases, e-mail, etc. The academic staff place different tests and tasks in the e-learning environment for self-control of knowledge, also, the system gives an opportunity to build various interim and module tests. The framework of the portal allows communication with all the academic staff members, but in the framework of current courses - also with the fellow students. The portal hosts discussion forums, regular surveys on the curriculum, quality of the study courses and academic staff that will deliver a study course, presentations, also other audio/video and technical aids.

"Regulation on the assessment of learning outcomes in a new edition" was approved by RTU Senate on 29 May, 2017, it is also included in RTU Regulation of Studies. According to the Regulation, every study course incorporates interim tests (tests, module tests, individual works, etc.), to ensure systematic control of the acquired knowledge. The order also specifies the procedure for academic progress testing, the rules for exam and test procedures, the conditions and procedure for clearance of academic arrears, responsibilities of the academic staff in assessment of outcomes, rights and responsibilities of the students during tests, as well as the procedure for submission and consideration of appeals. Interim test results and assessment grades are published in ORTUS system under the heading of a corresponding study course. Mistakes are analyzed and students are informed about them. Analysis of mistakes allows students to better understand unclear themes and eliminates the lack of knowledge or misunderstanding of certain aspects, which increases motivation of students to achieve yet better learning outcomes. In the e-learning environment, students can constantly monitor their progress in study course acquisition. The academic staff use analytical opportunities of e-learning to supervise students' activity and assess effectiveness of available materials. In case of online studies, the analytic opportunities of "MS Teams" are used to control student activities during online studies. The number of interactive activities grows during online studies, where students work in a collaborative environment submitting work results and replying to questions. For these purposes "MS Forms" opportunities also are widely used, whereupon student answers at once can be summarized analytically.

During the studies, the student-centered approach is adopted. Upon enrolment, students' level of knowledge of mathematics and programming is diagnosed. Students showing lack of knowledge in mathematics should additionally take the study course "Basic Chapters of Elementary Mathematics". Knowledge in programming can be increased through the study course "Algorithmization Practice". Each student has an individual study plan elaborated according to the sample plan. The study program includes compulsory elective and free elective study courses with

24 CP workload, which allows students to choose study courses based on their interests. Study courses also can be chosen at other higher educational establishments and outside formal educational studies. Such choice of study courses is regulated by RTU rules "Procedure for Recognition of Competencies Developed Outside Formal Education or from Professional Experience and Learning Outcomes Achieved in Previous Education at Riga Technical University". Individual changes to a study plan are confirmed by the Council of the Institute of Information Technology.

Opinions of students and feedback are taken into account both amending the curriculum of the current study course, and in case of changes to the study program. The academic staff should familiarize students with the results of surveys and changes. Mid-term surveys provide information about urgently needed amendments to a study course.

Study courses widely use self-learning opportunities in the test format. For example, Introduction to Operations Research specifies supplementary materials for each lecture, tasks and self-tests. Supplementary materials are provided as free access electronic resources or RTU subscribed e-books (EBSO and "ProQuest" databases). Currently RTU also is testing "O'Reilly" database and its learning opportunities and is planning its wide use in addition to the study course materials and self-learning opportunities. Already now, e-books available at RTU library are used, which allows students to independently acquire the curriculum of a study course in selected areas.

Certain study courses introduced flexible planning, whereas students are free to choose the time to attend classes. Students also actively use video lectures, which allows them to watch lectures repeatedly to revise. "Ortus" environment provides students with an opportunity to follow up their academic progress.

The most important aspects of the student-centered approach are described below.

1. Involvement of students in the study process and updating of the curriculum

According to RTU procedures, students can regularly give feedback about the curriculum. Students at the program are regularly involved in assessment of the study program quality and take part in decision-making bodies and advisory bodies (the Faculty Council, the Methodological Committee, the Study Field Committee). In addition to formal processes, students regularly meet with the Program Director, when the content and quality of studies is discussed. Mid-term and semestral surveys are organized to let students give feedback about the study courses. Furthermore, at any time students can apply to the Program Director or RTU Study Department with an option to complain anonymously, in order to let them know about problems arising during the studies. Graduates of the study program fill in the form about the studies in general.

2. Learning outcomes

At the study courses, the academic staff clearly define the learning outcomes to be acquired, as well as connect the results with the study program outcomes and credit points of the course. The academic staff take into account diversity of students, offering tasks of different complexity, as well as offering learning materials for the acquisition of both the basics of a study course and the in-depth knowledge of the curriculum of a study course. Students also are offered a vast variety of educational materials (documents, presentations, video recordings, interactive educational materials, etc.). During the first year, the students, who lack knowledge in the basics of mathematics and programming, are offered free elective study courses "Basic Chapters of

Elementary Mathematics” and “Algorithmization Practice”. In turn, students are entitled to suggest their graduation paper themes, thus achieving learning outcomes following the path interesting to them.

3. Mobility

RTU offers a wide variety of opportunities to participate in international mobility: 1) Erasmus+ program; 2) Nordtek and Baltech programs; 3) specialized cooperation programs and 4) financing of projects. In the framework of exchange programs, RTU provides students with an opportunity to study voluntarily at some foreign university for some period of their studies (normally, one academic term, but other mobility duration options also are possible), gaining a foreign IT education experience. Furthermore, RTU regularly takes up opportunities of attracting visiting researchers, who share their experience with students through individual guest lectures or the whole study course. Also, when meeting visiting professors at specially organized workshops, the academic staff involved in the program can adopt good practices, which visiting professors share. Mobility opportunities also are the means for advancement of academic staff qualification, wherein they gain experience at foreign universities. More detailed information about the attracted guest professors and mobility of the academic staff is given in Part 3.4.1. “Compliance of the qualification of the involved academic staff”.

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs <<< Regulation on Scholarships >>. Students take up employment early. Online attendance opportunities help students reconcile studies and work.

5. Teaching and learning methods

Within the program, various teaching and learning methods mentioned above are implemented, they are adapted by the academic staff to each particular situation (see the description at the beginning of the section). Students can attend individual consultations, including communication in the e-environment using RTU licenses on Zoom and MS Teams platforms, as well as Moodle instant message services.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Embarkment. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classes. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools). In the process of program implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.).

7. Development of the academic staff competences

The academic staff involved in the implementation of the program is provided with opportunities to improve their methodological and didactic skills on a regular basis. The process of academic staff competence development includes methodological seminars organized by the Institute of Business Computer Systems and FCSIT on the application of teaching and learning methods, including innovative machine learning methods, as well as RTU methodological conference. In the framework of SAM 8.2.2. project, the opportunity to undergo internship at IT companies is provided, thus letting the academic staff acquire the latest approaches and methods applied in the industry in order to cover them in their study courses. The project mentioned above also gave opportunity to attract new members of the academic staff, especially PhD students, to teaching activities in the study program.

8. Extracurricular student activities

Students at the program are offered a vast variety of extracurricular activities:

- the management of the program and the faculty actively support student self-government activities and encourages students to take part in them, thus letting them increase their autonomy, giving students an opportunity to implement their ideas, as well as the opportunities of supplementary studies outside lectures.
- Every student of the program is offered opportunities to take part in extracurricular activities (sport teams, dance groups, choirs, etc.).
- Students are also engaged in scientific and research work on the relevant issues in the field, taking part in both local and international projects, resulting in their chances to participate in international conferences.

The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Students develop their graduation Thesis during the third year of studies. In the Fall semester, the departments summarize and discuss the topics of the Thesis, which students are familiarized with during Week 4. The list of topics is supplemented with topics suggested by professional companies, for instance, in academic year 2021/2022 the company “Accenture Baltic” suggested a list of topics. Students, reconciling it with the academic staff, can also suggest topics relevant to their workplaces and their paper supervisor can be a company’s representative, who holds at least a Master degree in the field. In academic year 2021/2022, 12 Bachelor Thesis are being supervised/consulted by company representatives. The topics of the Thesis also are aligned with the institute’s PhD thesis topics, if a PhD student supervises the Thesis, and with the institute research project themes. For example, in academic year 2020/2021, a student defended the Thesis on “Solutions for close to real time processing of big data streams”, the results of which were used in the project “Development of a solution for integrated monitoring and predictive maintenance adapted to a dynamic IT infrastructure (DIPIM)”.

Since 2016, the total of 356 Bachelor Thesis have been defended. Those papers addressed cybersecurity issues (12), blockchains (4), augmented reality (9), big data technologies (44), cloud computing (7), agile software development (23) and progressive web technologies (42).

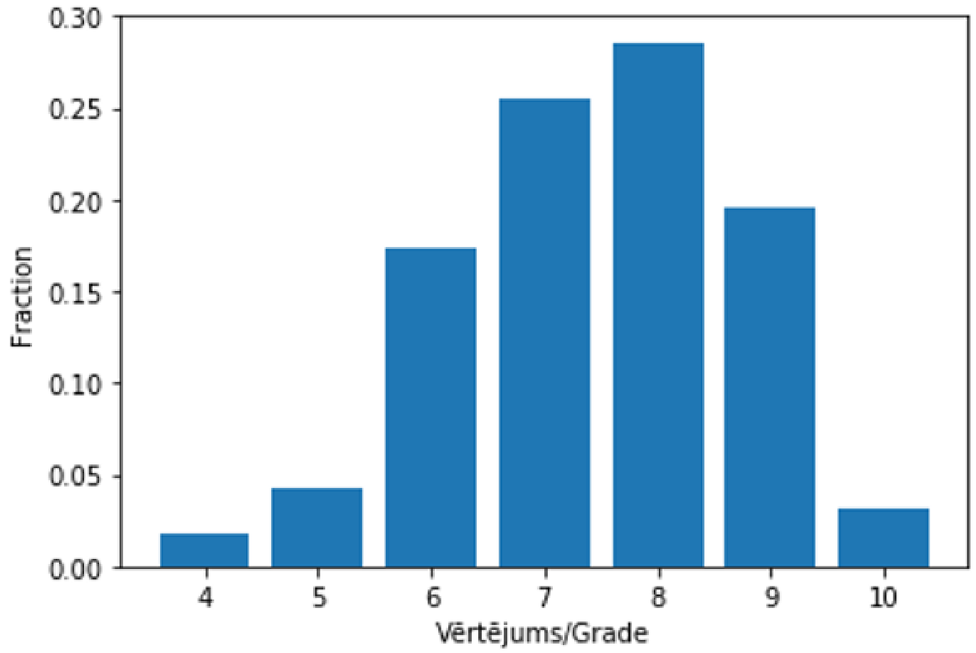
Key issues of cybersecurity and information protection are studied in a range of Bachelor Thesis. For instance, in 2021 they discussed such topics as “Application of innovative technologies for cybersecurity”, “Use of a camera sensor in data encryption”, “Comparative analysis of cybersecurity technologies”. Application opportunities of innovative technologies are studied intensively for digital transformation of companies. Bachelor Thesis analyze application opportunities for different innovative and promising technologies, including virtual and augmented reality, blockchains, internet of things and artificial intelligence. The examples of several topics include “Use of virtual and augmented reality in digitization of business procedures”, “Use of innovative technologies in planned maintenance of technical resources operated by an enterprise”, “Application of a blockchain in food quality management”, “Machine vision based counting of traffic objects in urban environment”, “Machine vision based solutions for identification of unloaded lorries”, “Machine learning based solution for public transport GPS data analysis”, “Solution for automated road maintenance reporting”, “Solutions for automated data acquisition from receipts”.

The study program in Information Technologies makes a special focus the practical application of results. More than 30 Bachelor Thesis have been developed in cooperation with institutions and companies, for example, “Computer vision-based solutions for identification of unloaded lorries” (Rīgas Satiksme Management Centre), “Machine learning-based solution for public transport GPS data analysis” (CATA and Road Transport Administration), “Automated road maintenance reporting solution” (Latvian Road Maintenance), “Solutions for automated data acquisition from receipts” (Accenture), “Development of the context-dependent solution for vehicle routing” (PwC), “Solutions for close to real time processing of big data streams” (TET).

Thesis supervised by lecturer Nadežda Zeņina in the field of transport simulations, written in cooperation with Ltd Solvers include: Study of data mining methods and their application in calibration of transport simulations, defended in 2018, Road safety and throughput capacity effects of the rail lights signal timing interval “Allred”, defended in 2020, Application of transport simulation models in development of street crosswalk reconstruction projects, defended in 2021. The results of the paper developed under supervision of Jūlija Strebko in 2019 - “Application of blockchain technology in management of supply chains'' were reported and awarded by the European Institute of Innovation and Technology’s (EIT) Food Community (EIT Food) Innovation Award for new ideas/start-ups (see "Representing a technology for continuous food quality monitoring”, Dienas Bizness, 23.10.2019. https://www.db.lv/zinas/rada-tehnologiju-partikas-kvalitates-nepartrauktai-uzraudzisanai-492484 (in Latvian only), as well as served as the basis for establishment of a new company Kedeon Solutions Ltd.

Student research works in cooperation with medical researchers (UL Faculty of Medicine and Institute of Clinical and Preventive Medicine) also promote development of innovative diagnostics methods (for example, Bachelor Thesis “Application of data acquisition methods in improvement of gastric disease diagnostics”, Bachelor Thesis “Development of a deep neural network model for cancer detection in breath data”, Bachelor Thesis “Breath sensor data analysis for gastric cancer diagnostics”), promote understanding about microbial resistance causing diseases (for example, Thesis Paper “Classification of bioinformatics data: gastric microbiome before and after antibiotics”, Bachelor Thesis “Clustering of bioinformatics data: gastric microbiome before and after antibiotics”, Bachelor Thesis “Application of data mining methods for analysis of specific weight of resistance genes before and after antibiotic treatment”) and human microbiome reactions to disease (Bachelor Thesis “Application of machine learning methods in analysis of microbiome differences depending on “H. Pylori” infection”).

The average Bachelor Thesis grade is 7.5 (calculated for all Thesis completed in the reporting period from 2013 till 2021). The mode is 8 (approximately 30% cases). The distribution of the grades corresponds to the expected distribution. The average grade is higher than 6.7 during the whole study process because students with low grades typically are not able to complete thesis and are not admitted to the defense. Staring 2021, a mandatory pre-defense is introduced. That is expected to reduce the fraction of average works. The average grade is negatively affected by poor writing skills of some of the students. The average grade is stable over the reporting period.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- FCSIT Institute of Information Technology;
- FCSIT Institute of Appllied Computer Systems;
- FCSIT Institute of Intelligent Computer Technologies;
- RTU Institute of Technical Physics;
- RTU Faculty of E-learning Technologies and Humanities.

RTU institutes and their departments ensure the training and methodological work: develop and update the curriculum, provide delivery of corresponding study courses, supervision and examination of PhD theses and carry out other activities related to teaching, methodological and research work. Elective study courses are offered also by other organizational units of RTU and higher educational establishments. The study program is granted with assistance of the general RTU support staff, which provides the functioning of the infrastructure.

Riga Technical University provides the study program with a corresponding learning environment. It comprises lecture halls and classrooms, laboratory equipment, e-learning environment and bibliographic resources. Each study course is provided with a necessary learning environment.

The studies take place at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at 10 Zundas Embarkment, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The faculty is located in the same building with RTU Scientific Library, providing rooms for group work and quiet reading rooms. The conference center offers a large lecture hall with 500 seats, the faculty has 15 lecture halls with 25-200 seats and 12 computer classes with 20-25 workstations. Students can use their laptops and connect to RTU Wi-Fi networks. The lecture halls are equipped with modern audio and video equipment, including a digital projector, a computer, a remote control, audio devices, microphones and cameras.

Modern software that corresponds to educational needs and the current trends is used in the study process:

- FCSIT cloud computing platform “CloudStack”, created within the ERDF project “(IKSA-CENTRS) Establishment of national research center of information, communication and signal-processing technologies". Students can also connect to "Microsoft Azure" cloud computing environment;

- agreements on the free use of software in research are signed, e.g., the agreements with MatLab, CPLEX, Microsoft, SAP, JetBrains, JIRA. In case of necessity, supplementary software and computing resources can be purchased on the funds of organizational units;
- Laboratory works within the study course DMI201 apply AnyLogic and MatLAB / Simulink software licensed for educational purposes. The study course DMI305 uses simulation software ARENA, software tools ARENA VISUAL DESIGNER, ARENA INPUT ANALYZER, ARENA OUTPUT ANALYZER, OPTQUEST for ARENA and SIMUL8, are used for individual tasks, as well as the system dynamics modelling tool
- Within the study course DMI374 "The Fundamentals of Logistics Information Systems", achievement of appropriate competences is ensured with the help of free software and personal data processing and mobile communication tools. For instance, in object navigation and identification learning GPS and NFC resources built in mobile phones are used, along with Google Play software. Conceptual modelling in the BPMN2 environment is based on free ArisExpress and Mindmeister versions, but critical contour discrete event system modelling is carried out in the learning environment Extend Suite. Free software SPSS is applied for statistical data processing. In testing of students' knowledge, EasyLMS and TeachSys environments regularly are used. For definition of practical work tasks, Youtube opportunities are engaged, but educational materials and video recordings are additionally placed on the shared platform. A targeted approach ensures good mobility and adaptation opportunities of the study course;
- Open-source software, including Linux, Docker, Kubernetes, Python, R and others, depending on the specifics of the study courses, are widely used. An integrated development environment "Eclipse" is used within the study courses on programming.
- During the studies, usage of shared resources is promoted, including "GitHub", "Miro" and "SharePoint".

RTU leases "Microsoft Windows" and "Microsoft Office" software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail services.

The server technologies are also used within study courses. Students are provided with remote access to specialized software using "Windows terminal services" including "Visual Studio", "Enterprise Architect", "SqlServer", "Eclipse", "PhpStorm", "MATLAB R2015b", "Microsoft Dynamics AX". More complex tasks are solved using a computer cloud, which consists of 14 servers each having 128GB RAM (DDR4@2400MHz), 2 pcs., CPU (Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz, 8 Core), disk array capacity 120TB and specialized servers. For example, DOP391 Information Systems Management uses two Supermicro servers, which consists of one 8-core processor Intel(R) Xeon(R) CPU E3-1275 v6 @ 3.80GHz, 64GB RAM memory, 1TB SSD disk space and 4TB SATA hard disk size. The second server consists of one 16-core processor Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz, 128 GB operation memory, 2TB SSD disk space and 8TB SATA hard disk size, to let students arrange their isolated work environment computer network security, solutions for design and testing of IT system supervision and management. Both servers have Proxmox VE hypervisor installed and students use "nested virtualization" technology.

In order to provide simple and effective identification of IT users, the IT user identity management system has been introduced, and as a result, each IT user has a unique electronic identity created and maintained, and made valid in all information systems. In addition to the mentioned above, a user session management system in IT systems is provided, where at one single application in RTU information systems, IT users do not need a repeated authorization. This offers the user experience of a joint integrated information system, which remembers various identification data and inputs it again to implement different scenarios of IT application.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple way of usage and convenient access to the catalogue of all IT services in the same place.

For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programs (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programs, the study course register (https://info.rtu.lv/rtupub/disc2/list - public part), development of individual study plans, drafting of orders, study courses and training, input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in administration of the study process.

In order to ensure efficient studies, “Moodle” e-learning environment is used, where all binding information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-teacher communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc. On ORTUS portal students can see their financial information, make requests for documents (certificates, academic records, copies of the agreement, etc.). Academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

More than 130,000 unique study course websites have been generated in the RTU e-learning environment since 2007. Students can connect and get access to electronic learning aids at any time and place.

Effective classroom resource management and planning of studies is provided by digitalization of classrooms and time schedules (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or member of the academic staff can see their schedule, specifying places, times, names of lecturers, classroom names and types of classes. To provide users with extra comfort, the system significantly facilitates planning and scheduling of classes, as well as optimizes classroom occupancy and use efficiency.

The Scientific Library of RTU is an academic library of state significance, which has obtained its status as a result of library accreditation. The Scientific Library of RTU provides the necessary information for RTU study process and research activities, performs library, bibliographic and information services for RTU students, teaching staff, and employees. The Library’s collection includes 1.3 million printed documents and e-resources in the databases relevant to RTU fields.

In 2016, significant investment was made in the development of the library infrastructure, with the construction of an additional 2240 m2 of space for the Central Library. The total area of the library premises is 6393 m2, of which 3417 m2 are for reader services. There are 713 workstations for library users. The library has four group rooms and six individual cubicles, a Western reading room and a conference room. The library is accessible to users with reduced mobility.

In order to improve the SL activities and to meet the information needs of academic and research staff, the Library Council has been established, which decides on replenishing the library collection with printed publications and subscribing to the necessary databases. The Library Council has approved the Compilation Policy of RTU SL Collection, which sets the basic principles of the collection development in accordance with the areas of RTU academic and research activities.

When RTU provides funding for the library, the funding for information resources for each study program is calculated. The collection is replenished according to the recommendations of the heads of study program, researchers, in compliance with the allocated funding. By contacting the SL Collection Development Department regarding replenishment of collection, the desired editions can be ordered at the Library website by filling out an order form (https://www.rtu.lv/lv/studijas/biblioteka/pakalpojumi-3 (only in Latvian), library's English language web site is https://www.rtu.lv/en/studies/scientific-library), an application form, contacting by phone 67089353, or visiting the Library at 5-105 Paula Valdena Street. The SL offers a guide, which includes websites of various Latvian and foreign publishing houses and bookstores for searching publications and e-resources.

Database subscription agreements are concluded both directly with the supplier and through the Cultural Information Systems Centre, which is the Latvian national representative for the international non-profit organization Electronic Information for Libraries (EIFL http://www.eifl.net/). The EIFL Licensing Programme offers libraries of state importance to subscribe to internationally recognized databases at a significantly reduced subscription fee that is not offered to individual subscribers, thus saving the financial resources of the libraries.

Every month, the list of the newly-received literature is published in the SL newly-received literature bulletin (https://www.rtu.lv/lv/studijas/biblioteka/jaunieguvumi (only in Latvian)).

The database subscriptions maintained by RTU Scientific Library (https://www.rtu.lv/en/studies/scientific-library/electronic-resources):

- ProQuest Ebook Central, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, EBSCOhost eBook Academic Collection, Wiley Online Library, SpringerLink, The International Monetary Fund.
- Databases financed by the Ministry of Education and Science available to RTU Scientific Library: ScienceDirect, SCOPUS (Elsevier), Web of Science.
- Latvian databases: LETA, Letonika, the Database of Latvian Standards (available on the premises of the Library).

Database usage at the Scientific Library of RTU has been growing since 2016.

The new library premises have allowed to extend the range of services. Since the opening of the new premises in 2018, the number of visits to the library has increased from 103,825 to 691,200. The Central Library is open to users from Monday to Saturday. (https://www.rtu.lv/writable/public_files/RTU_library_general_info_summer_2022.pdf). There is a 24/7 reading room. During the summer period, the Central Library is open every weekday with reduced opening hours.

The SL information sources are provided in open access. Books and periodicals relevant for the study fields are located in the main building of the Scientific Library (5 Paula Valdena Street) in compliance with UDC indexes. The last copy of the oldest editions that comply with RTU profile is stored in the library repository. They are always available to users.

The on-duty librarian helps find the necessary resources. More detailed information and consultations are provided by bibliographers. The SL has librarians responsible for particular fields of science (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija (only in Latvian)).

Searching for library resources is ensured by the Primo Discovery search tool (https://primolatvija.hosted.exlibrisgroup.com/primo-explore/search?sortby=rank&vid=371KISCRTU_VU1&lang=en_US). It allows searching for the information in the library catalog (https://kopkatalogs.lv/F/?func=find-b-0&local_base=rtu01), subscribed databases, as well as in databases created by the Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/bibliotekas-veidotas-datubazes). Searching for the information in the electronic common catalog (https://kopkatalogs.lv/F), one can simultaneously obtain information about the available resources in 12 libraries in Latvia. Both the electronic catalog and RTU portal ORTUS can be used to reserve the library resources remotely. Remote access to databases is also provided. Since the introduction of RFID technology, users have been able to use five book-dispensing self-service vending machines and return books to a book-sorting vending machine around the clock. Book usage term can be prolonged remotely.

The SL provides students, academic staff and other interested parties with different types of individual consultations and group training in information literacy (https://www.rtu.lv/en/studies/biblioteka/lietotaju-apmacibas).

Editions that are not available in the Scientific Library are delivered through an interlibrary subscription or international subscription. Internet access is provided throughout the library. The SL provides copying, scanning, printing and binding services, as well as there is a self-service canteen.

The SL can be contacted via: Ask the Librarian , using information e-mail, calling to the information phone number (https://www.rtu.lv/en/studies/scientific-library).

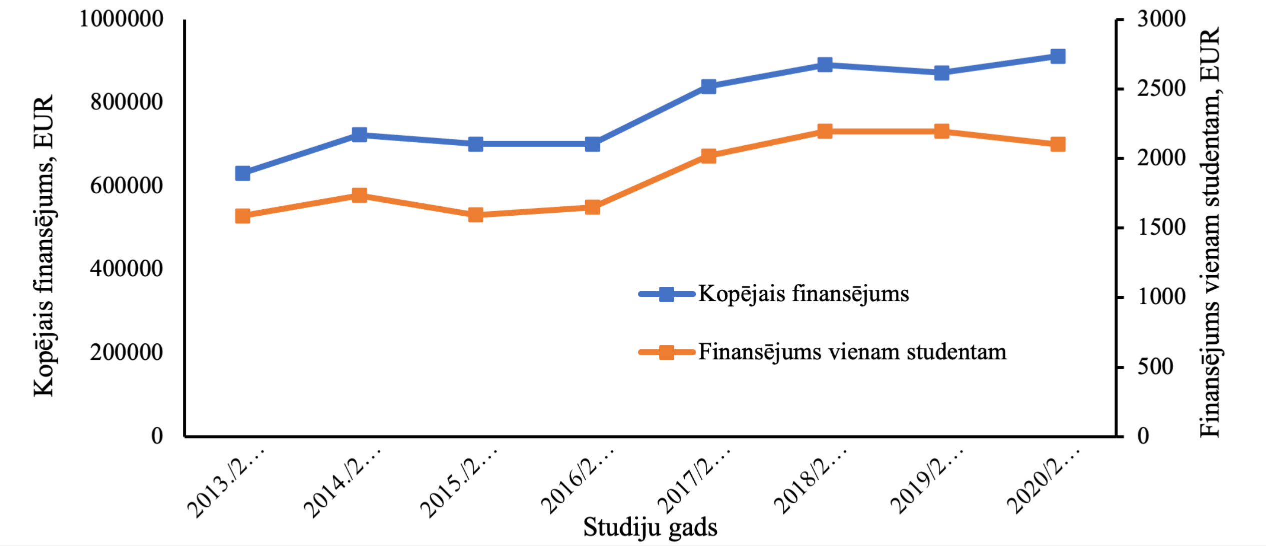
The academic staff are advised to recommend students at least one e-book from the available bibliographic resources.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The study program is financed from the state budget of the Ministry of Education and Science of the Republic of Latvia and the tuition fees. 95% financing on the study program “Information Technologies” comes from the state budget of the Ministry of Education and Science, because Information Technologies is a priority program according to employers’ recommendations, which is assigned appropriate state budget funding. Distribution of the funding is set out in RTU regulations "On Approval of the Methodology of Distribution and Allocation of Funds to Organizational Units of RTU in Academic Year 2021/2022". They specify allocation of funds for centralized RTU services and organizational units that provide the study courses. The full annual tuition fee is set at EUR 1,275.

The available funding for the study program is illustrated in the chart. During the reporting period, the study program funding has increased by 30%. The increase is conditioned by the larger number of students and increase of per-student funding by 25%. The growth is in line with the general cost increase in Latvia, but it is lower than the global growth in higher education costs.



The major part of costs is formed by remuneration (47%). The appropriate financing also is allocated to maintenance of the infrastructure. Certain funding is planned for the purchase of bibliographical resources, although a part of these resources is purchased at RTU (IEEE) or state level (Scopus). The business trip costs are 0%, because due to COVID-19 pandemic-caused limitations, trips were not organized.

Expense items	Sum	%
Average actual costs per 1 student, EUR	2100.8	100%
Remuneration	966.368	46%
Employer's SSIC, compensations and benefits	231.088	11%
Business trip expenses	0	0%
Payments for services	63.024	3%
Materials, energy resources, inventory	0	0%
Purchase of books and journals	84.032	4%
Purchase and modernization of equipment	21.008	1%
Administration costs *	273.104	13%

Infrastructure costs *	357.136	17%
Social security costs	105.04	5%

The minimal number of students in the study program that ensures its cost-effectiveness is 120 students for all academic years. The fact that a part of the study courses in the program is delivered together with other FCSIT study programs should be taken into account.

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "Funding distribution between the cost items".

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

23 professors and 18 associated professors, performing the duties of responsible instructors, are involved in the implementation of the study program. 21 assistant professors or lecturers also take positions of responsible instructors. Such composition of the staff attests that highly qualified and experienced specialists are involved in the study process, younger colleagues, who can accumulate teaching experience, also are joining the team

Position	Professors	Assoc. professors	Assist. professors	Lecturers
Number	23	18	11	10

The proportion of the responsible instructors with a PhD degree is 85%. In line with the study program profile, 43 members of the academic staff have a degree in engineering, and 8 members of the academic staff, who deliver study courses in mathematics, have a PhD degree in mathematics. The study courses in Economics and Humanities are delivered by the academic staff with scientific degrees in the corresponding fields. The studies also involve young specialists with a Master degree.

Scientific degree	Dr.sc.ing.	Dr. math.	Dr. oec.	Dr.sc.soc.	M.sc.ing.
Number	43	8	2	2	7

Implementation of the fundamental study courses during 1 academic year involves the academic staff of high pedagogical qualification, which is proved by the learning aids in mathematics, for instance, prof. I. Volodko's "Collection of typical tasks in mathematics" and "Calculus". The academic staff also have published many publications on didactics and e-learning issues in scientific periodicals and introduce the latest advances in practice:

- Anohina-Naumeca, A., Petrovica, S., Balina, S. & Kikans, A. 2021, "The tool for migrating learning content from Moodle to open edx", ACM International Conference Proceeding Series, pp. 105.
- Dzenite, I. & Volodko, I. 2017, "Mathematics teaching problems and its solution at Riga Technical University", 16th Conference on Applied Mathematics, APLIMAT 2017 - Proceedings, pp. 492.
- Grabis, J., Sandkuhl, K. & Stamer, D. 2015, International ERP teaching case: Design and experiences. Lecture Notes in Business Information Processing 241, pp. 131-150
- Jurenoka, S. & Jurenoks, A. 2018, "A method for learning scenario selection and modification in intelligent tutoring systems", CEUR Workshop Proceedings, pp. 335.
- Koliskina, V. & Iltina, M. 2018, "Visualization of mathematical concepts in teaching linear and vector algebra to first-year engineering students", 17th Conference on Applied Mathematics, APLIMAT 2018 - Proceedings, pp. 570.
- Prokofyeva, N. & Uhanova, M. 2017, "Methodology of group work organisation for student learning performance improvement", Vide. Tehnologija. Resursi - Environment, Technology, Resources, pp. 133.

The academic staff in the study program possess advanced digital skills. Assoc. prof. A. Romānovs and assoc. prof. A. Anohina-Naumeca have been awarded RTU prizes for the best e-learning courses.

The studies also involve experts in the field. For instance, the study course DOP391 Management of information systems is delivered by Jans Šlihte, Deputy Rector for Digital Transformation, and Mārtiņš Bonders, the manager of the IT department at the international company Ltd "Riot Engineering". In the surveys students, have highly appreciated the essential contribution of this study course to improving their practical skills. DOP390 Computer Networks is delivered by Aigars Riekstiņš, the manager of VOAVA/NVD IT Infrastructure Department. The mentioned members of the academic staff are permanently employed practicing university lecturers. Visiting lecturers from the industry are involved in delivering certain lectures.

The academic staff are engaged in the professional advancement program. Henrihs Gorskis, Māra Pudāne, Katrina Boločko and Alla Anohina-Naumeca underwent internship at Buffalo University (USA). Darja Plinere took part in the project Specific Objective SAM 8.2.2. "To Strengthen Academic Staff of Higher Education Institutions in the Areas of Strategic Specialization", where she was awarded a PhD degree and continued academic activities at the study program.

ERASMUS program contributes much to in-service training. For instance, assoc. prof. A. Romānovs participated in the academic exchange programs at Autonomous University of Barcelona, Spain (2021, 2019, 2018), Vilnius Gediminas Technical University, Lithuania (2019), VEL Tech Chennai, India (2018).

Promotion of further cooperation occurs in the framework of EUt+ program.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, renewal of the academic staff has been considered as one of the tasks, which has been completed upon replacement of retiring colleagues with new qualified academic staff. Starting with the academic year 2016/2017, the average age of the academic staff at the program was 49,8 years, but since the academic year 2021/2022 it has been 47,7 years. Generally, the academic staff during the reporting period is estimated as stable. During the reporting period, different assistant professors, i.e., assist. prof. Arnis Kiršers (2020), assist. prof. Rūta Pirta – Dreimane (2021) and assist. prof. Henrihs Gorskis (2021), as well as associated professors, i.e., assoc. prof. Jānis Kampars (2018) and assoc. prof. Inese Poļaka (2021) were elected for the first time. In 2016, a young professor Egils Ginters stated working at the study program. Four professors retired in the reporting period. Generally, during the reporting period the number of professors decreased as a result of generation change, but the number of associated professors, who previously occupied positions of assistant professors, increased. The total number of involved responsible academic staff during the reporting period was stable.

Year	Professors	Associate professors	Assistant professors	Lecturers and assistants
2013/2014	20	14	16	9
2021/2022	23	18	11	10

Distribution of the academic staff corresponds to the needs of the study program. The proportion of the involved professors and associated professors even exceeds the one observed at the leading universities around the world. The studies involve a greater number of assistants, who help students individually at practical classes.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Sequencing of the study courses ensures successive acquisition of knowledge and the curricula of the study courses are coordinated. Descriptions of the study courses specify the necessary preliminary knowledge and study courses to be acquired previously. Cross-referencing among the study courses is the matter of regular discussions at academic departments, which are coordinated by the Head of the study program. The experience exchange amongst the academic staff is promoted at the methodological seminars organized by FCSIT.

General study courses (first year of studies) are delivered to a large number of students, and they involve many members of the academic staff, who share experience and information. For implementation of the study course SDD700, cross-disciplinary teaching teams have been established, which unite representatives of social and engineering sciences to promote acquisition of the course in cross-disciplinary perspective. For evaluation of the study papers within in the study course of Design Laboratory, members of the academic staff delivering other study courses are also invited to share experience about application of the knowledge acquired within study courses and the issues to be analyzed in the subsequent study courses. Student surveys evaluate the overlapping of the study course curriculum. If a significant level of overlapping is detected, the curriculum is amended.

The current student to staff ratio is 18, which is in compliance with the average level among the leading universities around the world.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	DBI0_AkadProgr_Diploms_EN.zip	DBI0_AkadProgr_Diploms_LV.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DBI0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DBI0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DBI0(43526)_AtbilstibaValstsStandartam_AkadBak_EN.pdf	P06_3.2.1_DBI0(43526)_AtbilstibaValstsStandartam_AkadBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DBI0(43526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DBI0(43526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DBI0(43526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DBI0(43526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DBI0(43526)_StudyCoursesdescr_ENG.zip	P10_DBI0(43526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Finance Management Information Systems (42484)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Finance Management Information Systems*
Education classification code	*42484*
Type of the study programme	*Professional bachelor study programme*
Name of the study programme director	*Ingars*
Surname of the study programme director	*Eriņš*
E-mail of the study programme director	*Ingars.Erins@rtu.lv*
Title of the study programme director	*Dr.oec.*
Phone of the study programme director	*67089440*
Goal of the study programme	*The aim of the study program is to educate and train software engineers for professional career in software engineering with professional knowledge in programming languages, software development technologies, data structures and algorithms, software design project management, basic database technologies, computer system architecture and functioning, as well as competitive knowledge, skills and competences in financial management that would allow the graduates to apply for international certification, including the Scottish Qualifications Authority (SQA) certificate.*
Tasks of the study programme	*Tasks of the study program:* *– to provide knowledge on software engineering, computer hardware, database technologies, basic methods of Artificial Intelligence and provide insights into the best practices of the industry;* *– to provide knowledge and practical skills in information systems design and development, including the development of the related documentation and provision of the information system functioning;* *– to develop students' abilities to use theoretical knowledge in setting and solution of definite tasks;* *– to enhance students' competence to develop software, acquire skills in application of software engineering tools and environments;* *– to develop students' ability to independently acquire, assess and use new software products necessary for conducting professional activities;* *– to develop students' skills to design information, data base, intelligent and software systems;* *– to provide practical experience offering the students the opportunity to practically apply the acquired knowledge in solution of engineering tasks.*

Results of the study programme	*As a learning outcome, the students develop basic skills to independently work and make decisions, as well as to apply the acquired knowledge in practice. In the course of studies, students: – acquire knowledge in software engineering, implementation and maintenance; – are able to draw up software documentation in accordance with the requirements of software engineering standards; – are able to understand and analyze software design descriptions, requirement specifications, system documentation and codes of the maintained systems, as well as to introduce changes in the code; – are able to use software engineering tools and environments; – are able to select adequate algorithms, methods, software products and tools in problem solution; – are able to think creatively to develop new methods and approaches to problem solution with the help of computer systems; – are able to use good programming style and apply best industry practices; – are able to develop software relevant for a definite task, acquire and use software engineering tools and environments; – are able to develop programming guidelines; – are able to participate in project development and management, to work in a team and to lead, plan and coordinate activities in a work group; – are aware of the topical financial development tendencies and relations, are competent in the processes occurring in the field of finance and are able to explain them, draw relevant arguments and make decisions in accordance with the changing situation; – are able to manage assets, compile financial statements and calculate taxes; – are able to use quantitative methods of financial analysis to ensure efficient performance of the enterprise; – are able to forecast financial results of the operational activities of an enterprise, compile financial plans and budget of an enterprise, to draw up investment projects, assess and manage financial risks.*
Final examination upon the completion of the study programme	*Upon completion of the study program, students pass the national examination, including the defense of the Bachelor Paper at the open meeting of the State Examination Commission (SEC). Simultaneously, testing of the essential fundamental, theoretical industry specific and field of specialization specific knowledge is carried out. SEC shall include at least five members. The Head of the Commission and at least a half of its members shall be representatives of professional industry organizations or employers. SEC collegially assess the knowledge, skills and competences of the students according to a 10-grade scale.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*160*
Admission requirements (in English)	*General Secondary Education or 4-year Vocational Secondary Education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Bachelor Degree in Computer Systems*
Qualification to be obtained (in english)	*Programming Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*160*
Admission requirements (in English)	*General Secondary Education or 4-year Vocational Secondary Education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Bachelor Degree in Computer Systems*
Qualification to be obtained (in english)	*Programming Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The duration of the professional Bachelor study program “Finance Management Information Systems” is 4 years. The study program was licensed on 30 May 2018 (License No. 04051-176).

The volume of the study program is 160 CP or 240 ECTS. Type of implementation is full-time (4 years).

It is an inter-university joint study program, which is implemented by Riga Technical University (RTU) and BA School of Business and Finance (BASBF).

The study program meets the requirements set in the occupational standard “Software Engineer”. The study program comprises the study courses aimed at developing knowledge and competence in programming, software engineering, maintenance, implementation, testing and requirement setting, as well as study courses on financial issues and economics.

According to the Latvian ICT association LIKTA the current version of the standard (approved in 2009 and available: https://registri.visc.gov.lv/profizglitiba/dokumenti/standarti/ps0227.pdf) is outdated and does not reflect the actual needs of the industry. The study program has been evaluated based on a working version of the occupation standard developed by a working group organized by LIKTA and submitted for the approval in March 2022. The approval of the standard should be done in 2022. The working version of the standard used for the evaluation is added as an additional annex.

Degree and qualification to be obtained – Professional Bachelor Degree in Computer Systems and Qualification of Software Engineer.

Full-time study program is implemented in compliance with RTU standard schedule, according to which an academic year consists of two semesters, the duration of each semester is 20 weeks, i.e., 16 study weeks and 4 examination weeks. General secondary education or vocational secondary education is required to be enrolled in the study program.

The study program is implemented in Riga.

During the reporting period, certain changes have been made to the study program in order to improve it and provide students with the theoretical knowledge and basic skills necessary to fulfill the duties required by the profession.

Since licensing the study program, the following significant changes have been made to the parameters of the study program (see Appendix P09):

- From the study program is implemented in Latvian to the study program is implemented in Latvian and English.
- The section “Languages” of the study program has been supplemented with the study course “Latvian Language” (2 CP) for foreign students; the course will be implemented by BA School

of Business and Finance.

- The volume of General Education Study Courses (A.1) has been increased from 12 CP to 13 CP and the volume of Compulsory Study Courses (A) has been increased from 98 CP to 99 CP.
- The volume of field-specific professional study courses (B.1) has been decreased from 14 CP to 13 CP and the volume of compulsory elective study courses (B) has been decreased from 24 CP to 23 CP.

The changes made have been coordinated with the cooperation partner - Banking University (BA).

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The professional Bachelor study program “Finance Management Information Systems” has been developed in accordance with the Law on Higher Education Institutions of the Republic of Latvia and complies with the Classification of Education of the Republic of Latvia.

The professional Bachelor study program “Finance Management Information Systems” complies with Cabinet Regulations No. 512 of 26 August 2014 “Regulations on the State Standard of Second Level Professional Higher Education” and RTU regulatory documents. The code of education classification is 42484.

During the implementation and development of the study program, the principles of the Latvian Qualifications Framework (LQF) and the European Qualifications Framework (EQF) are observed.

Upon completion of the study program, a student is awarded a professional Bachelor degree that corresponds to the 6th level of the Latvian Qualifications Framework and the European Qualifications Framework, as well as corresponds to the 5th level of the Latvian Professional Qualifications. Graduates of the study program are awarded a Professional Bachelor Degree in Computer Systems and a Qualification of Software Engineer (Appendix P28 – A Sample of Diploma and Diploma Supplement).

The study program has been developed taking into account RTU strategic goals, market supply and potential demand.

Study program activities promote implmentiaion of the keynote defined in RTU Strategy for 2021–2025, i.e., it ensures “[...] the proactive link between the activity of the university and the needs of the national economy, focusing on high quality and effectiveness. The basis for the activity of RTU is the study process built on science, innovation and in cooperation with the industry, which ensures education and training of specialists required by the Latvian national economy, thus serving as a foundation for sustainable growth of Latvia” (https://www.rtu.lv/writable/public_files/RTU_strategy_for_2121_2025_eng.pdf).

The study program corresponds most closely to the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, as the curriculum of the study program focuses on software engineering and includes knowledge and skills relevant to information technology, computer science and, to some extent, computer engineering and computer control.

The study program is't only about the use of financial systems (as it could be concluded from the name of the study program), but also about the development, implementation and maintenance of such systems, which is directly evidenced by the awarded degree and professional qualification - **Professional Bachelor Degree in Computer Systems** and a **Qualification of Software Engineer** qualification , as well as the topics of study courses in the study program. Its study courses on system development, implementation and maintenance are: "Field-Specific Theoretical Basic and IT Study Courses" 38 CP, "Field-Specific Professional Study Courses" 34 CP, in the amount of 6 CP the possibility to choose study courses from "Field-Specific Study Courses".

The title of the study program "Finance Management Information Systems" covers all areas related to software engineering, as well as areas related to financial management. Finance management information systems development requires knowledge in computer science, information technology, computer engineering and computer control. The program focuses on computer systems development (systems analysis, systems modeling, design, and algorithmization) for financial and non-financial sector.

The aim of the study program is to educate and train software engineers for professional career in software engineering with professional knowledge in programming languages, software development technologies, data structures and algorithms, software design project management, basic database technologies, computer system architecture and functioning, as well as competitive knowledge, skills and competences in financial management that would allow the graduates to apply for international certification, including the Scottish Qualifications Authority (SQA) certificate (for a sample learning agreement, see Appendix P28).

To ensure the interrelation of admission requirements, study program content and learning outcomes, the development of professional competences takes place by acquiring the field-specific theoretical basic and information technology related study courses (38 CP), field-specific professional study courses (48 CP), field-specific study courses (14 CP), undertaking practical placement (20 CP), as well as elaborating and publicly presenting the Bachelor Thesis (12 CP). General competences, in turn, are improved by acquiring general education study courses (12 CP), humanities and social sciences study courses (4 CP), languages (6 CP), as well as free elective study courses (6 CP).

The learning outcomes to be achieved within the study program fully ensure the fulfillment of the requirements set in the occupational standard. The title, aim, tasks, learning outcomes to be achieved and the professional qualification of the study program are closely interrelated (for more details on the compliance of the study program with the professional qualification, see Appendix P7; for more details on the internal coherence of the study program – the compliance of the title, aims and tasks with the learning outcomes to be achieved – see Appendix P8).

According to the Latvian ICT association LIKTA the current version of the standard (approved in 2009 and available: https://registri.visc.gov.lv/profizglitiba/dokumenti/standarti/ps0227.pdf) is outdated and does not reflect the actual needs of the industry. The study program has been evaluated based on a working version of the occupation standard developed by a working group organized by LIKTA and submitted for the approval in March 2022. The approval of the standard should be done in 2022. The working version of the standard used for the evaluation is added as an additional annex.

The learning agreement is drawn up in compliance with Cabinet Regulation No. 70 of 23 January 2007 "Terms and Conditions to be Stipulated in the Learning Agreement" (for a sample learning agreement, see Appendix P28).

After obtaining the Bachelor degree and professional qualification, students have the opportunity to pursue a Master degree.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The study program was launched in 2018. Therefore, there are currently no students who have completed the study program. The professional Bachelor study program "Finance Management Information Systems" is simultaneously implemented by two Latvian higher education institutions: Riga Technical University and BA School of Business and Finance.

One of the potential employment sectors for the graduates of the study program is the finance sector, where the automation of business processes is playing an increasingly important role. The growing regulatory requirements are one of the drivers of these processes, and the implementation of solutions requires specialists with interdisciplinary skills and competences in both the IT sector and finance. The joint study program implemented by RTU and BASBF provides focused knowledge in business finance and management.

Graduates' employment opportunities and forecasts

The Ministry of Economics has made medium and long-term labor market forecasts, covering the employment needs of the sectors by occupation and education until 2040. The forecasts are based on the target scenario of economic growth and the corresponding demographic trends. Labor market forecasts take into account current global economic development processes, including the impact of the Covid-19 pandemic on the Latvian economy and labor market in the coming years. The changes in the habits of the population introduced by the crisis not only reduce certain activities, but also create new opportunities and needs in the labor market. The less affected sectors are expected to recover faster and will be the main drivers of the economy in the coming years. The most significant increase in the number of new jobs in the medium term is expected in scientific and technical services, construction, information and communication services, as well as manufacturing. By 2027, these sectors will create almost 25,000 new jobs, which is about 9/10 of the increase in all new jobs in the corresponding period. The total number of economically active population could decrease by 1.3% by 2027. At the same time, the negative impact of demographic trends on labor supply will be decreased by the growth of economic activity of the population. By 2027, the participation rate of the population in the labor market could exceed 71%. In turn, the unemployment rate could fall below 6% by 2027, thus highlighting the problem of labor shortage. The labor market will be increasingly affected by trends in the digitalization of the economy and the automation of jobs. In recent years, innovation cycles have become much faster. Self-service sales terminals, virtual assistants and bots, autonomous vehicles, big data processing and cloud computing are just some of the innovations that have a significant impact on labor force and skills that are in demand. With the development of technology in the coming years, an increasing number of jobs will be automated. The largest job losses are expected in professions that involve a high number of manual and repetitive activities, as well as in professions related to provision of direct services, such as salespersons and cashiers in the retail sphere, call operators and similar professions. Thus, middle-skill jobs are most likely to be affected by long-term automation trends. Meanwhile, the digitalization of the economy and the robotization of jobs will increase the demand for highly skilled labor. In total, by 2040, the number of jobs in high-skilled occupations could increase by about 80,000 and make up more than a half (52% or 461,000) of the total number of jobs in the national economy. It should be borne in mind that job automation is less likely to happen in the areas/professions that require a high level of education, high social interaction and leadership, as well as planning and coordination of complex environment/conditions on a day-to-day basis.

The population with the secondary general education, primary education and lower level of education will face serious challenges related to finding a job, while there will be a shortage of ICT and engineering specialists.

Wider use of various technologies and innovations on a daily basis will increase the demand for highly skilled workforce with STEM education, especially for IT and engineering professionals. In general, in the medium term there could be a shortage of highly qualified specialists in natural sciences, ICT and engineering. By 2027, the shortage of highly qualified STEM specialists may increase to approximately 14 thousand.

In the National Development Plan for 2021–2027 (NDP), one of the priorities is knowledge and skills for personal and national growth – the rhythm of modern life requires a person to be flexible and ready for change in order to successfully develop their knowledge and skills and adapt to the needs of the labor market. The priority focuses on the most important resource for individual and national growth, i.e., the amount and quality of knowledge and skills, the acquisition of which leads to good jobs, doing business or creating new practical/theoretical knowledge. Implementing the professional Bachelor study program “Finance Management Information Systems”, both RTU and BA School of Business and Finance observe the presence of a high demand for IT and financial specialists in the labor market. The priority – competitiveness and prosperity of the companies – is an economic and social criterion for the quality of life. It is made up of the competitiveness and productivity of companies, which allow a person to perform a job according to a level of their skills and abilities in order to earn a living, which, together with local demand, has a positive effect on economic growth and quality of life. An individual’s ability to make savings and hold other assets increases the material well-being and reduces welfare risks. The following factors are essential for the implementation of the priority: innovation and digital economy – the Internet and the digital environment not only provide access to services and information, but also offer opportunities for remote work and education, thereby reducing the use of transport. Improving digital skills is a prerequisite for an inclusive labor market to increase the productivity of companies that do not take full advantage of the digital age.

Correspondence of the skills and competences acquired by the graduates to the global trends in the development of the labor market and the industry. The Employers’ Confederation of Latvia, in cooperation with the career and education portal *prakse.lv*, has acknowledged for several years in a row that RTU students are best prepared for the requirements of employers and therefore highly demanded in the labor market. For example, the professional study program “Computer Systems” implemented by RTU has been the highest rated study program for several years. Therefore, the professional Bachelor study program “Finance Management Information Systems” has taken over the best practices from the study program “Computer Systems”. In its turn, employers highly evaluate the quality and topicality of the study program “Finance” implemented by the academic staff of BA School of Business and Finance. The Employers’ Confederation of Latvia, in cooperation with the career and education portal *prakse.lv*, has created the TOP of the educational institutions and study programs most recommended by employers. The Bachelor study program “Finance” of BA School of Business and Finance is ranked 5th. The study program “Finance” is recommended by 83 companies, including such recognizable companies and industry leaders as KPMG Baltics JSC, Development Financial Institution Altum JSC, SEB Banka, Tele2 Shared Service Center, Alfa Finance Ltd, Altero Ltd, Deloitte Latvia, Ernst & Young

Baltic, BDO etc. (www.prakse.lv). This is also confirmed by the publication drawn up by the Ministry of Education and Science (MES) in April 2021 on the latest monitoring of the alumni of higher education institutions, which analyzes the employment rate of graduates of Latvian higher education institutions during the first few years after graduation. The number of graduates of BA School of Business and Finance who occupy highly qualified positions is assessed as very high – 87; thus, BA School of Business and Finance is ranked 5th among state higher education institutions in this respect. Every week, BA School of Business and Finance receives more than 15 job offers in various positions in the field of finance at public administration institutions, financial institutions and enterprises both at local and international enterprises and institutions.

The Covid-19 pandemic has led to major changes worldwide – digital services have become commonplace throughout society. For example, according to the study on the use of banking services in Latvia conducted by Swedbank JSC, almost one fifth of people have started paying with a credit card or by phone instead of cash due to Covid-19. The vast majority (87%) of these people admit that they will continue to make cashless payments even after the pandemic. One in three people, in turn, noted that they used contactless payments wherever possible even before the crisis. Significant figure to be mentioned: currently 90% of the cards issued by Swedbank JSC are contactless. Due to rapid digitalization and the limitations during the Covid-19 pandemic, people were forced to adopt new habits, rather than choosing this path themselves. 57% of the population admit that now they visit a bank branch very rarely or even never, and only 29% of the population visited a bank branch once during the past year. In 7% of cases, people admit that they have acquired the basics of online banking due to the limitations during the Covid-19 pandemic and do not visit a bank branch (most of them had such a habit before). At present, the main channels of contact with the bank are online banking and mobile application.

Worldwide, financial institutions are under significant pressure to reduce their reliance on the legacy infrastructure and improve their core banking systems in order to promote a better customer experience through the cloud. According to the FinTech study by KPMG Ltd, in 2021 especially the first tier banks expressed an increasing interest in FinTech companies, which could help perform the above-mentioned activities. In 2021, there was a growing interest in FinTech, which could help companies process data more efficiently, thus contributing to better decision-making in terms of lending, insurance, AML (Internal Control System for Anti-Money Laundering and Countering Terrorism) and fraud prevention. Financial services are now more accessible than ever before, partly thanks to digital solutions that will be provided and developed by the graduates of the professional Bachelor study program “Finance Management Information Systems”.

According to FinTech Review 2021 of Latvia, the lack of local talent is another challenge for businesses in Latvia; there is an increasing shortage of IT/software developers compared to other occupations. According to companies, the reason is not related to the lack of appropriate skills or demand for high salary, but there is simply a lack of people.

According to the respondents of the survey, it is difficult to find specialists in the field of IT/Software Development (61%). The respondents provided the following answers to the question “Why is it difficult to find specialists?: “Lack of talented workforce” (59%) and “Lack of necessary skills” (31%).

Taking into account the current trends in the use of information technologies in the financial sector and the gradual transition of financial services to the digital environment, interdisciplinary knowledge is becoming increasingly important and there is a demand in the labor market for specialists with in-depth knowledge of software engineering and finance. Graduates of the professional Bachelor study program “Finance Management Information Systems” will be able not only to work at the companies in the financial sector, developing and improving digital solutions to ensure various business processes, but also to successfully participate in IT project working groups as a financial sector expert in developing various IT solutions.

The study program was launched in 2018. Therefore, only 3 students have graduated from the study program at the moment.

Senčenko Ričards a software engineer at AS "Swedbank".

Finanšu pārvaldības it inženieris – darba tirgū pieprasīts speciālists | Rīgas Tehniskā universitāte (rtu.lv) (Only in Latvian)

Rolands Kalituha AS "Printful Latvia" programmer, makes orders for the non-financial sector.

Mārtiņš Pokromovičs is continuing his master's studies.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Applicants are admitted to the professional Bachelor study program “Finance Management Information Systems” at both higher education institutions. BA School of Business and Finance provides 13 state budget-funded seats, while RTU offers only tuition fee-based seats. Seven students study at RTU and 24 students – at BA School of Business and Finance. A total of 31 students have been enrolled in the program; 42% of them have been granted state-funded seats. This statistical indicator can be viewed as a positive factor, as it indicates the high quality of the study program and a demand for its graduates in the labor market. In the process of admission of new students every academic year, it can be observed that there is intense competition for the state-funded seats, which testifies to the high evaluation of the program among the prospective students.

During the reporting period, the study program was implemented only in Latvian. In the future, the study program is planned to be implemented in Latvian and English.

Table 1

Student Number Dynamics by Study Year and Academic Year (Latvian Language)

	2018/2019		2019/2020		2020/2021		2021/2022	
	RTU	*BASBF*	RTU	*BASBF*	RTU	*BASBF*	RTU	*BASBF*
The total number of students at the program	*6*		*9*		*23*		*31*	

Number of students at the program at each higher education institution	*3*	*3*	*3*	*6*	*6*	*17*	*7*	*24*
The 1st study year	*3*	*3*	-	*3*	*3*	*11*	*2*	*9*
The 2nd study year			3	*3*	-	*3*	*2*	*9*
The 3rd study year					*3*	*3*	-	*3*
The 4th study year							*3*	*3*

Analyzing the total number of students since the study program has been licensed, it may be concluded that the number of students at the program steadily increases every year (see Table 1. *Student Number Dynamics by Study Year and Academic Year*). See Appendix P05 for other statistical data on students at the study program.

Factors of change with regard to the increase in the number of students:

1. The number of state-funded seats provided at BASBF has been increasing;
2. Public policy supports STEM sectors;
3. Topicality of the IT sector in the economy, the impact of COVID-19, and ample students' job opportunities;
4. The program is becoming more and more recognizable.

Factors leading to the decrease in the number of tuition fee paying students:

1. Desire of high school graduates to study abroad;
2. Demographic situation in the country;
3. Public policy in favor of STEM sectors, i.e., there is a large number of state-funded seats available, which means that it is less attractive to pay for one's studies; as an example, it is worth mentioning RTU Faculty of Computer Science and Information Technology (see Fig. 1);
4. Low solvency of the population and a simultaneous increase in the tuition fee.

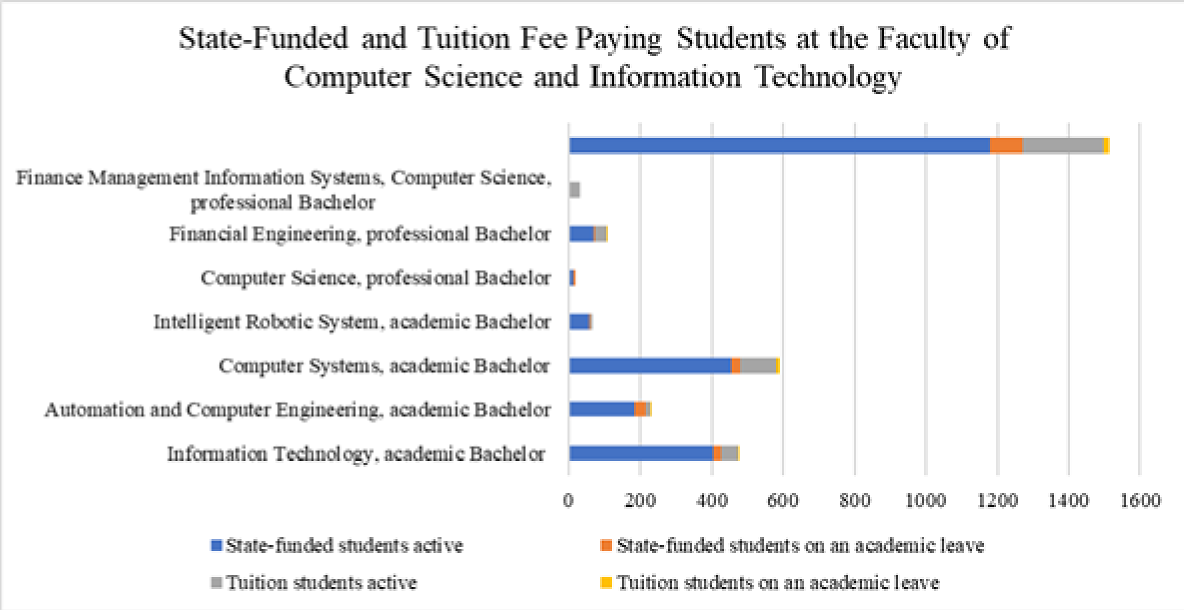


Figure 1. State-funded and tuition fee paying students at RTU Faculty of Computer Science and Information Technology.

Analyzing the ratio of state budget-funded students to tuition-fee paying students at RTU Faculty of Computer Science and Information Technology (FCSIT), it can be concluded that only 16.06% of students are tuition-fee paying students, i.e., 1270/243 students. High school graduates will give first preference to a study program that provides state budget-funded seats. In addition, the contributing factors that determine whether or not students choose the professional Bachelor study program “Finance Management Information Systems” are the tuition fee, which is the highest one compared to other study programs within the FCSIT, and the duration of studies, which is four years, compared to three-year long studies within academic Bachelor study programs.

Analyzing the number of students at the study program by type of funding, i.e., state-funded seats and tuition fee-paying seats, it can be concluded that the number of tuition-fee paying students at the study program exceeds the number of state budget-funded students each year. Thus, it demonstrates that with an increase in the number of tuition-fee paying students, the study program is becoming more and more popular.

The number of students is also affected by the dropout rate. The highest dropout rate is usually observed during the first two years of study. It is related to the academic failure of students who face difficulties with the acquisition of mathematics and other courses in exact sciences. This can be explained by a low level of mathematical knowledge that is provided at Latvian schools. To reduce the dropout rate due to advanced math courses, RTU annually tests the enrolled students’ knowledge of mathematics. According to the test results, students with poor knowledge of mathematics are offered additional math classes, which are free of charge, with the aim of increasing students’ knowledge and reducing the dropout rate due to academic failure. The second important reason for a high dropout rate due to academic failure is the commencement of employment by students during their 2nd or 3rd study year, as the number of job offers is very high in the IT sector. Working students cannot combine work and studies, often opting for a job where a starting salary may be much higher than the national average.

Analyzing student number dynamics, dropout rate and the reasons for droput with regard to the development trends of the IT industry in the world and in Latvia, it is envisaged that the number of students at the professional Bachelor study program “Finance Management Information Systems” will increase and the program will have a wide range of development opportunities.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Description of the study program development process.

The development of the professional Bachelor study program “Finance Management Information Systems” was stimulated by discussions organized by BASBF in the process of establishing the Master study program “Cyber Security Management” (2014–2015). At that time, the needs of the financial intermediation industry and service industries were explored, the BASBF study development areas were discussed at the BASBF Advisory Board, as well as from 2015 until the development of the study program, the BASBF organized extended expert discussions, working groups, seminars and conferences on the development trends of digitization, process automation, information systems in relation to the sectors that create demand for the BASBF graduates. An expert discussion “On the Prospects for the Development of the Information Technology Field at the Higher Education Institution with Specialization in Finance and Business Management” organized by the BASBF on 11 May 2015 was especially dedicated to the integration of information technology content in financial and business management education. The aim was to identify the current and future IT competency needs of financial intermediaries, large service companies and industrial companies in relation to product development (including the development of IT service platforms and service solutions with a significant IT component), customer service, internal process management and risk management in order to create an opportunity to more precisely define the IT study field program and course niches at the higher education institution specializing in business and financial education on the basis of the acquired information. The discussion also addressed the challenges of creating resources and infrastructure appropriate for high quality study process, as well as the possibilities of cooperation with industry in the development of IT study programs and courses in the selected specialization niches. Among the participants of the discussion, there were the Head of the Baltic Customer Service Channel Competence Center at Swedbank JSC Ģirts Bērziņš, Chair of the Board of the Latvian Open Technology Association Jānis Treijs, Board Member of DNB Bank Intars Sloka, Head of New Business Area Development at DPA Ltd Aigars Jaundālders, CEO at VediCard Ltd Ludmila Bērziņa and other experts. Taking into account the experts’ recommendations, the BASBF drew up the conceptual substantiation of the study program “Finance Management Information Systems” and addressed the management of the FCSIT of Riga Technical University to cooperate in developing and implementing such a study program. When a decision was made to cooperate within a joint professional Bachelor study program “Finance Management Information Systems”, at various stages of study program development Riga Technical University and BA School of Business and Finance continued to discuss the curriculum and related competency development aspects at the Advisory Boards of the higher education institutions, as well as at seminars, workshops and conferences.

The conference “Digitization in Education, Public Sector and Business: Challenges and Opportunities” held on 7 April 2017 was dedicated to the discussion of this study program, where Professor Jānis Grundspeņķis of Riga Technical University delivered a presentation on the study program. The Governor of the Bank of Latvia Ilmārs Rimšēvičs, Deputy State Secretary of the Ministry of Environmental Protection and Regional Development Edmunds Beļskis, National Security Adviser to the President of Latvia, Secretary of the National Security Council Jānis Kažociņš, Rector of Rēzekne Academy of Technologies Edmunds Teirumnieks, Head of the State Education Content Center Guntars Catlaks, Chair of the Board of the Latvian Open Technology Association Jānis Treijs and other experts participated in the conference, as well as evaluated the study program.

The presentation and discussion of the study program took place on 28 February 2017 and on 8 March 2017, with the participation of the Board Member of Riga International Airport SJSC Normunds Feierbergs, Chair of the Board of the Alternative Financial Services Association of Latvia Gints Āboltiņš, CEO at VediCard Ltd Ludmila Bērziņa, Economic Adviser at the European Commission Representation in Latvia Mārtiņš Zemītis, as well as representatives of commercial banks. During these events, the experts positively assessed the idea of the program and the developed curriculum, supporting its implementation in the shortest possible perspective, as well as agreeing to provide consultations for the improvement and updating of the program in the process of its implementation.

Three independent experts took part in the evaluation process of the study program: Chair of the Board of the Alternative Financial Services Association of Latvia Gints Āboltiņš, the Board Member of Riga International Airport SJSC Normunds Feierbergs and Digital Development Manager at SEB Bank JSC Iļja Nogičevs. First of all, the experts highly acknowledged the joint initiative of two leading Latvian higher education institutions to develop such an interdisciplinary study program, during implementation of which these higher education institutions would have the opportunity to represent their strengths. Riga Technical University has the capacity to educate and train highly qualified specialists in the field of information systems, while BA School of Business and Finance has an established set of practices and tools to train highly qualified professionals in the financial sector. Both higher education institutions have been highly valued by Latvian employers for several years in a row. The experts also acknowledged that RTU and BASBF created a competency development tool required not only for the financial sector but also for other digital technology related industries.

In the process of developing a common quality assurance system, the higher education institutions identified it as part of the strategic management of each higher education institution. During its development, the partner institutions examined the quality management system (QMS) used by each partner, QMS best application practices, as well as the legal framework enabling the parties to implement the joint study program.

In the process of developing the study program management system, the partner institutions took into account the terms and conditions stipulated in the cooperation agreement regarding the implementation of a joint professional Bachelor study program "Finance Management Information Systems" signed between RTU and BA on 18 October 2017 (see Appendix P04).

The cooperation agreement specifies the process of study program implementation and monitoring in such matters as:

- Degree and qualification to be awarded to the graduates of the program;
- Allocation of responsibilities, addressing academic, administrative and financial issues;
- Regulatory requirements governing the process of awarding the qualification, assessment requirements, principles of recognition of knowledge acquired during studies;
- Establishment of a joint internal quality control body to oversee the entire program;
- Requirements for common quality measurements, activities, plans, obligations and process owners;
- Regular monitoring and feedback analysis, frequency of meetings.

The daily management of the study program will be ensured by the heads of the study program and the Program Council established by the partner institutions, see the Regulation of the Study Program Council in Appendix P04. It is generally responsible for the implementation of the study program. Each higher education institution performs study quality measurements in accordance with the internal procedure. The quality measurements are regularly discussed at the Study Program Council, and according to the results obtained, each of the partner institutions takes the necessary corrective measures based on the recommendations developed by the Council. The management structure of the professional Bachelor study program "Finance Management Information Systems" is demonstrated in Figure 1.

The study program has uniform admission requirements, which include:

- Admission requirements are clearly defined, procedures are explained to the stakeholders;
- Student admission management: the necessary uniform admission requirements have been developed;
- Clear agreement on tuition fees and their amount;
- An agreement has been reached on the financing of the study program and how to deal with the situation if the funds are insufficient for the implementation of the study program.

In the process of developing the common curriculum, the following principles have been observed:

- There is a clear agreement on the curriculum profile;
- There is an agreement on the amount of credit points and the procedure for awarding them (ECTS);
- The curriculum is supplemented and improved by mutual cooperation of the parties;
- The parties have a common understanding of the level of competence to be achieved in determining the learning outcomes of the curriculum and study courses.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The content of the study program was approved at the meeting of RTU Senate on 20 February 2017 (Minutes No. 607) and at the meeting of BSBF Senate on 28 February 2017 (Minutes No. 3). **The study program was launched in 2018. Therefore, there are currently no students who have completed the study program.** The professional Bachelor study program "Finance Management Information Systems" is simultaneously implemented by two Latvian higher education institutions: Riga Technical University and BA School of Business and Finance. To ensure compliance of the program with the requirements of the labor market, the study module "Financial Management" (BASBF) implemented within the study program has obtained international accreditation issued by the Scottish Qualifications Agency (SQA).

The study program complies with the guidelines of RTU Strategy and Development Program for 2021–2027 (RTU stratēģijas 2020.-2025. gadam_21.12.2020_Final). RTU Strategy for a new planning period is a consecutive continuation of the previous strategy of the university for 2014–2020 (RTU Strategija un Attistibas programma 2014.-2020. gadam.pdf). It has been developed in compliance with the objectives and priorities set out in the national development planning documents, including:

- The Sustainable Development Strategy of Latvia until 2030 (Latvia 2030) (Latvijas ilgtspējīgas attīstības stratēģija 2030.gadam | POLSIS (mk.gov.lv));
- The National Development Plan of Latvia for 2021–2027 (NDP2027) (Latvijas nacionālais attīstības plāns 2021.–2027. gadam (pkc.gov.lv));
- The UN Sustainable Development Goals (Agenda 2030) (ANO Ilgtspējīgas attīstības mērķi | Pārresoru koordinācijas centrs (pkc.gov.lv)).

The mission of RTU is to create a competitive, educated, innovative and creative future. The vision of RTU – an internationally competitive, dynamic and modern university of science and technology. Keynote of the strategy: High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities of the Baltic and Nordic region, which is acting based on a study system built on research, innovation and cooperation with the industry. RTU educates and trains European and global-level engineers – leaders: developers of new technologies. RTU positions itself as a cornerstone of the development of Latvia by ensuring education of specialists necessary for the national economy and development of new services and products, serving as a basis for sustainable growth of Latvia.

RTU Development Program envisages two strategic objectives. The first objective is related to the accomplishment of study, research and valorization goals: excellence in research, high quality study process and sustainable valorization. The second objective is related to the accomplishment of the institutional excellence goals: digitization, sustainable development, efficient financial and administrative management, internationalization, communication and cooperation, human resources development.

Strategic specialization of BA School of Business and Finance includes the provision of modern, high-quality business and financial management education based on the future labor market needs, being in line with interdisciplinary fields. The mission of BASBF: BA School of Business and Finance offers high quality studies and research in business and finance for ambitious personalities. High quality studies, research, international cooperation, professional and creative staff, achievements of students and graduates, close cooperation with the world of finance and business earn an excellent reputation of BASBF. Vision of BASBF: BA School of Business and Finance is a credible and internationally recognized partner for the development of personality (Misijas vēstījums, stratēģija (ba.lv)).

The sustainability of BASBF is based on four principles:

1. Offer of accredited study programs that are recognized in Latvia and abroad;
2. Content of studies corresponding to the needs of employers and society;
3. Study programs that are in demand by prospective students;
4. Adequate infrastructure, human resources and financial stability of BASBF.

The study program is positively evaluated in the Financial Sector Development Plan of Latvia for 2021–2023 (https://www.fm.gov.lv/en/media/7347/download), in which Latvia has defined the objective of promoting the availability of stable, secure, internationally competitive, as well as innovative financial services that ensure the sustainable development of the Latvian economy and the strengthening of Latvia's position as a regional financial center. Financial technologies have experienced rapid growth in recent years. They have not only laid the foundation for a new industry, the FinTech industry, but also brought about changes in the traditional banking services and related internal processes. Banks are motivated not only to follow the dynamic offer of the FinTech sector, but also to invest and build the human resource potential in order to create their own technological solutions or to absorb FinTech developments in their own service platforms. In the financial services sector, there has also been a trend towards automation and robotization of front-office functions, characterized by the fact that along with the advancement of digital technology and the development of artificial intelligence technologies, in the near future automated workstations will perform customer service in the voice mode (will be able to analyze customers' letters and speech). The trends described are characterized by structural changes in the financial services sector, signaling a significant reduction in the need for personnel performing routine operations and being involved in easily automated processes. This is evidenced by the fact that the number of bank branches serving customers is rapidly declining. The COVID-19 pandemic has had an even greater impact on the remote nature of financial operations. At the same time, there is a growing demand for relatively complex competences that include both IT skills and financial literacy. Experts note that the research "Pulse of Fintech 2017" by the Alternative Financial Services Association of Latvia (http://lafpa.lv/content/uploads/2017/02/FinTech-Pulss-2017_25.07.pdf) directly and indirectly confirms the growing importance of financial and IT competences, which will be reflected in both product development and the demand for highly qualified employees. Experts of FinTech companies regularly emphasize in discussions that the combination of financial literacy and information technology skills is an exclusive competence. The labor market in Latvia, similar to other developed countries, sets new requirements brought about by the rapid automation of processes in many service sectors, among which the financial services sector stands out. The role of information systems custom designed for the needs of companies in streamlining business processes and improving the efficiency of business operations is significantly increasing. There is a growing demand in the industry for professionals with interdisciplinary knowledge in both programming and financial management. Therefore, it is important that the content of the study program incorporates the knowledge, skills and competences required for both financial management specialists and information systems engineers, as well as integrates knowledge required to obtain the internationally recognized SQA Financial Manager Certificate. Taking into account the current global trends in higher education, such an approach of combining IT competence with knowledge of other business areas is a promising perspective that motivates students to strive for in-depth knowledge, skills and competences that can be acquired by completing the professional Bachelor study program "Finance Management Information Systems". At the same time, it will be an effective solution in the financial sector and financial intermediation services environment that sometimes have a shortage of specialists possessing knowledge in the field of IT, especially taking into account the growing demand of the FinTech industry for professionals with relevant competences.

The experts consider that the study program developed by RTU and BASBF (1) meets the current and future needs of companies and the labor market; (2) includes study courses, the acquisition of which will provide an opportunity to acquire the necessary skills and knowledge to work as a software engineer at financial companies and projects; (3) will ensure high quality study process.

The content of the study program provides high quality knowledge for obtaining the Qualification of Software Engineer and the internationally recognized SQA qualification in financial management. Implementing the study program, its aim is taken into account – to educate and train highly qualified specialists, i.e. software engineers (according to the 5th level of the Latvian Professional Qualifications, occupational standard "Software Engineer"), that are ready for the changing socio-economic conditions in the local and international labor market and are able to build professional career in software engineering with professional knowledge in programming languages, software development technologies, data structures and algorithms, software design project management, basic database technologies, computer system architecture and functioning, as well as possess competitive knowledge, skills and competences in financial management. A large part of the courses help students acquire the most important competences required by a software engineer. For example, almost all IT-related study courses develop student ability to choose adequate algorithms, methods, software products and tools to solve a particular problem. Furthermore, most study courses, such as software development projects, help students acquire virtually all the skills relevant to the IT field, as students are required to test these skills in simulation projects. Other study courses also contribute to the achievement of various learning outcomes and the development of different skills and abilities. Programming courses cover everything related to the respective programming approach, for example, the study course “Object-Oriented Programming” deals with everything related to the object-oriented approach, starting from the implementation of algorithms, the tools of the object-oriented approach and ending with the programming style. The main study courses that contribute to the acquisition of competences necessary for a software engineer are the following: “Database Management Systems”, “Applied Software Automation Tools”, “Programming Languages”, “Operating Systems”, “Introduction to Artificial Intelligence”, “Data Structures”, “Algorithmization and Programming of Solutions”, “WEB Technologies”, “Object-Oriented Programming”, “Computer Systems Engineering”, “Fundamentals of Computer Systems Design”, “Computer Aided Solutions in Microsoft Programming System”, “Information Systems Security” and “Object-Oriented System Analysis”. The requirement to include at least three study projects in the professional study program has been fulfilled, i.e., the following study courses have the project part: “Financial Mobile Application Development (project)”, “Object-Oriented Programming Practice (study project)”, “Process-Oriented Systems Development (study project)” and “Web-Application Creation (study project)”. Financial management competences are acquired within the study courses in the field of finance, such as “Financial System Organization”, “Accounting System”, “Taxes and Audit System”, “Financial Services on the Internet”, “Risk Management in Finance”, “Management Accounting and Business Finance”, “Financial Management”. Within these study courses, the necessary competences in the field of finance are acquired: the students are aware of the topical financial development tendencies and relations; are competent in the processes occurring in the field of finance and are able to explain them, draw relevant arguments and make decisions in accordance with the changing situation; are able to manage assets, compile financial statements and calculate taxes; are able to use quantitative methods of financial analysis to ensure efficient performance of the enterprise; are able to forecast financial results of the operational activities of an enterprise, compile financial plans and budget of an enterprise, to draw up investment projects, assess and manage financial risks. General education competences are acquired in the following study courses: “Economics”, “Business Organization”, “Law”, “International and Commercial Law”, “Environmental Protection, Civil Defense and Labor Safety Organization”.

The vision of the professional Bachelor study program “Finance Management Information Systems” is implemented taking into account the opinion and interests of students, employers and professional organizations; furthermore, it is consistent with RTU mission, vision, goals and objectives. The professional Bachelor study program “Finance Management Information Systems” is a program open to cooperation, which takes into account the goals and objectives of higher education, as well as all interests of the national economy that are linked to the needs of students and employers.

Since the issuance of the license, the content of the study program has been updated, mutually complementary, would meet the objectives of the study program and ensure the achievement of learning outcomes, as well as to meet the needs of the FinTech industry for the latest scientific trends and innovative practice solutions. The changes in the study program have been justified to avoid duplication of the content of the study courses and the fragmentation of the study program.

On 1 February 2019, the following changes in the professional Bachelor study program “Finance

Management Information Systems" were approved:

- The volume of Part A.2 "Field-Specific Theoretical Basic and IT Study Courses was increased from 36 CP to 38 CP. The following study courses were excluded form this part: "Mathematics" (9 CP), "Applied Software" (2 CP), "Operating Systems" (4 CP), and the following study courses were included: "Mathematics" (9 CP), "Applied Software Automation Tools" (2 CP), "Operating Systems" (3 CP), "Banking Information Systems" (3 CP).
- The volume of Part A.3 "Field-Specific Professional Study Courses" was decreased from 50 CP to 48 CP. The study courses "Algorithmization and Programming of Solutions" (5 CP), "Banking Information Systems" (3 CP) were excluded and the study course "Algorithmization and Programming of Solutions" (6 CP) was included in the study program.

On 9 December 2019, the following changes in the professional Bachelor study program "Finance Management Information Systems" were approved:

- The study courses "Discrete Mathematics" (2 CP) and "Data Structures and Algorithms" (4 CP) were excluded and the study courses "Discrete Mathematics" (3 CP) and "Data Structures and Algorithms" (3 CP) were included in the study program in Part A.2 "Field-Specific Theoretical Basic and IT Study Courses".

On 14 April 2021, the following changes in the professional Bachelor study program "Finance Management Information Systems" were approved:

- The study course "Database Technologies" (4 CP) was excluded and the study course "Database Management Systems" (4 CP) was included in the study program in Part A.2 "Field-Specific Theoretical Basic and IT Study Courses";
- Within Part A.3 "Field-Specific Professional Study Courses", the study courses "Large Databases" (4 CP), "Fundamentals of Information Systems Development" (4 CP) and "Fundamentals of Information Systems Development (study project)" (2 CP) were excluded from the program. The following study courses were included in the study program: "Technology of Large Databases" (2 CP), "Systems Analysis and Knowledge Acquisition" (2 CP), "Fundamentals of Computer Systems Design" (2 CP), "Process-Oriented Systems Development (study project)" (2 CP), "Web-Application Creation (study project)" (2 CP).

On 30 May 2022, the following changes in the professional Bachelor study program "Finance Management Information Systems" were approved:

- Within Part A.1 "General Education Study Courses", the study course "Environmental Protection, Civil Defense and Labor Safety Organization" (2 CP) (implemented by BASBF) was excluded and the study course "Environmental Protection, Civil Defense and Labor Safety Organization" (3 CP) (implemented by BASBF) was included in the study program. It should be noted that according to these changes, the volume of Part A.1 "General Education Study Courses" increased from 12 CP to 13 CP and, respectively, the volume of Part A "Compulsory Study Courses" increased from 98 CP to 99 CP.
- Within Part B.1 "Field-Specific Study Courses", the study course "Taxes and Audit System" (4 CP) (implemented by BASBF) was excluded and the study course "Taxes and Audit System" (3 CP) (implemented by BASBF) was included in the study program. It should be noted that according to these changes, the volume of Part B1 decreased from 14 CP to 13 CP and, respectively, the volume of Part B "Compulsory Elective Study Courses" decreased from 24 CP to 23 CP.
- Within Part A.3 "Field-Specific Professional Study Courses", the study course DSP303 "Technology of Large Databases" (2 CP) was excluded and the study course DSP797 "Data Models of Database Systems" (2CP) was included in the study program.

- Transition from the study program that is implemented in Latvian to the study program that is implemented in Latvian and English. To include the study course “Latvian Language” (2 CP) for foreign students in the section (B.6) “Languages”; the course will be implemented by BA School of Business and Finance.

The main changes concerned specifying the study courses and ensuring compliance with RTU and Latvian laws and regulations. Each member of academic staff involved in the implementation of the study program has a sufficient number of publications on the themes covered within a respective study course. In order to provide the study program in English, each study course has at least one lecturer corresponding to the knowledge of English.

Academic year consists of two semesters, the duration of each semester is 20 weeks, i.e., 16 study weeks and 4 examination weeks.

The study process is organized in such a way that the themes of students’ study and research papers include issues that are relevant in the field. The study program, in the process of its implementation, is supplemented and updated on the basis of labor market surveys and in consultation with employers and practicing specialists.

As BASBF and RTU implement professional higher education study programs, a great deal of attention is paid to cooperation with employers, organization of regular meetings with industry representatives and attraction of new cooperation partners.

The students took part in the following events and activities:

- A visit was organized and several guest lectures were held at the financial technology company TWINO, where students were introduced to current competences and career development opportunities in the financial technology sector. At the financial technology company, the discussions were led by its IT Manager Nauris Bloks.
- The visit to the financial technology company MINTOS was organized, and the guest lecture on current events in the field of financial technologies was delivered by company co-founder Mārtiņš Šulte.
- The visit to the financial technology company 4Finance was organized, and the guest lecture was delivered on the current trends in the FinTech sector and the role of IT in the competitiveness and development of the financial sector. The discussion at the company was moderated by its Chief Technology Officer Roland Schaar. The discussion was held in English.
- Students were given the opportunity to participate in guest lectures delivered by the Association of Business Services Leaders in Latvia “ABSL Latvia”, which were organized at BASBF.
- Students were given the opportunity to participate in guest lectures organized by the Bank of Latvia at BASBF.
- Students were invited to participate in international interdisciplinary student projects, hackathons, the international innovative student cooperation platform “Demola Latvia” and other similar activities regularly taking place at BASBF.

Year after year, cooperation is expanding, priorities are changing, mutual interest is growing and industry feedback is increasingly provided.

Cooperation between higher education institutions and employers takes place in various ways:

- Involvement of employers in the implementation of the study process, for example, delivering guest lectures, providing field trips, membership in the Internship Evaluation Committee and State Examination Commission;
- Participation of employers in BASBF and RTU annual events, such as BASBF Career Day and

RTU Career Day;
- Internship and job offers by employers.

Students are involved in the further development of the program through student surveys. Student surveys are conducted regularly – in each academic year, 1st, 2nd, 3rd and 4th year students are invited to express their opinion on the performance of the academic staff members upon completion of each study course. After public presentation of the Bachelor Thesis, 4th year students will be invited to express their opinion about the study program in general – to evaluate its organization and implementation. The survey results are analyzed during the audit of the study program and are used to improve the organization and implementation process of the study program in the next academic year. The results are discussed at the meetings of the Program Council and of the responsible departments of each partner institution.

See Appendix P06 – Compliance of the Study Program “Finance Management Information Systems” with the State Education Standard; Appendix P08 – Course Mapping of the Study Program “Finance Management Information Systems”; Appendix P09 – Course Content of the Study Program “Finance Management Information Systems”.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Comprehensive achievement of learning outcomes is ensured by the study program. The learning outcomes have been formulated both at the level of the study program and at the level of the study courses. The learning outcomes to be achieved within the program are discussed with the students at the beginning of each study course, as well as they are available in the ORTUS environment. Descriptions of the study courses implemented by BASBF are also available in the ORTUS environment and on the BASBF intranet – BAIS. The interrelation between the learning outcomes of the study program and those of the study courses is ensured. According to the learning outcomes of the study program, the content and volume (in credit points) of study courses are stipulated, while according to the learning outcomes of the study course, the respective themes and their volume in hours are defined. The learning outcomes to be achieved upon completion of all study courses are tested using the appropriate assessment methods. The study courses to be implemented by RTU and BASBF are determined taking into account the learning outcomes of the study program. The learning outcomes to be achieved by the study program and those to be achieved by the study courses are adjusted by the Program Council. Labor market surveys and consultations with employers and practicing specialists significantly contribute to the improvement of the study program and study courses.

At both higher education institutions, students evaluate the work of academic staff members, the content of the study courses, the adequacy and sufficiency of theoretical knowledge for understanding and acquiring the material, individual tasks, acquired practical skills, the instructors' attitude and cooperation with students, assessment methods and criteria, as well as other indicators. Once a semester, students evaluate the work of academic staff members in writing (in the ORTUS environment) by completing the questionnaire. Questionnaires are anonymous. Every semester, the heads of the study program of both higher education institutions discuss the results of the survey and, if necessary, propose changes in the content of the study courses and teaching methods at both higher education institutions. The results of the survey are also discussed at the meetings of the Program Council that is entitled to propose changes in the curriculum of the study courses and teaching methods at both higher education institutions. Every semester, the heads of the study program of both higher education institutions discuss the results of the survey with the respective academic staff members and propose changes to the study course curricula and teaching methods.

The study program is implemented using different types and modes of study, observing the requirements formulated in the regulatory enactments, the basic principles of the study process organization set by RTU, as well as fulfilling all the requirements of the study courses. The procedure for the assessment of students' knowledge, skills and competences at RTU is determined by RTU Regulation on the Assessment of Learning Outcomes approved at the meeting of RTU Senate on 29 May 2017. The Regulation stipulates the basic principles and procedures for the assessment of student achievements at the respective study level. Students who are matriculated at both higher education institutions have the opportunity to challenge the assessment of learning outcomes at the higher education institution where the respective study course is implemented. (For more details see RTU Regulation on the Assessment of Learning Outcomes approved at the meeting of RTU Senate on 29 May 2017, Minutes No. 610).

In the academic groups of full-time students of RTU Bachelor study programs, the group leaders are elected from among the students. Their main task is related to ensuring effective communication between students and other parties involved in the study process (RTU Regulation on Student Group Leaders).

The teaching methods applied within the study courses, as well as the assessment methods are chosen by the instructors responsible for a respective study course according to the specifics of the course curriculum and study program, as well as taking into account students' needs. The methods integrating the principles of student-centered teaching and learning that are used in the study program promote the achievement of the aims and learning outcomes of the study courses and the program as a whole. One of the basic principles of RTU FCSIT study programs is democracy and dialogue with students, as well as their active involvement in the improvement of the study process. Students can participate in the improvement of the study process directly by expressing their wishes to the instructor of a respective study course, the head of the department or the head of the study program, or through the FCSIT Student Self-Government. Compliance with the principles of student-centered learning (hereinafter – SCL) is constantly ensured.

The study program is implemented by means of RTU interactive e-learning environment on the portal www.ortus.rtu.lv, which is created on the Moodle platform that is regularly used by the students of the study program, academic staff and guest lecturers. The portal provides students with access to all relevant information during the study process. It contains all current study courses (abstracts of study courses, requirements for successful completion of a respective study course, course contents, materials of lectures and practical classes, recommended literature and other materials), information about the student's academic performance and completed study courses, notifications, library information, access to study and scientific literature and databases, e-mail, etc. In the e-learning environment, instructors upload various tests and tasks for the students' self-control of their knowledge, as well as the system allows instructors to make various types of mid-term assessment tests. On this portal, it is possible to communicate with every instructor, and within the framework of the current study courses it is also possible to get in touch with the groupmates. The portal provides discussion forums, presentations, and other audio/video and technical aids.

At RTU and BASBF, the study process is organized using theoretical lectures, homework, study project presentations, practical classes, seminars, case studies, tests and exams. Emphasis is placed on a balanced study load both throughout the semester and between different elements of the study process. BASBF instructors organize study tours and study visits to financial institutions within the framework of financial study courses; the relation of the study program content with the specifics of the financial sector is also ensured, students not only acquire theoretical knowledge, but are able to use it in everyday situations, analyze problems and provide arguments supporting their point of view.

In academic matters, an individual approach is ensured in accordance with the methodology "On the Academic Staff Work Planning Guidelines" approved by the order of RTU Rector, which stipulates that the academic staff member shall provide tutorials to every 25 students per study course in the extent of 15% of the lecture volume. Additional tutoring hours are envisaged for the supervision of the study papers and projects, internships and graduation papers. Pre-examination tutorials are usually organized before the exams. If necessary, students can contact an instructor outside of tutoring hours, sending questions in the form of messages or in the appropriate study course forum within the ORTUS system or asking questions via e-mail. In the study courses implemented by BASBF, students communicate with instructors via e-mail.

In order to promote understanding of academic integrity, all new students are introduced to the Code of Ethics, Internal Code of Student Conduct and RTU Code of Academic Integrity. At the beginning of the study course, lecturers introduce students to the principles of academic honesty. A **zero-tolerance policy** is adopted in the study courses in relation to breach of academic integrity. All the submitted papers are checked for plagiarism.

Some of the possible breaches of academic integrity:

- Copying task solutions from other (current or previous year) students or other sources of information during mid-term tests, practical work and/or exam;
- Copying the answers to the test questions from the study materials or any other source;
- Code copying, even if the code is freely available on the web.

In 2022, the FCSIT developed a System for Plagiarism Detection in students' independent assignments, which was integrated in the ORTUS environment.

In the process of elaboration of the Bachelor Thesis, regular meetings of academic advisers and students are planned, during which the advisers evaluate the progress and can provide immediate feedback on the students' work. Such a system facilitates greater interaction between instructors/students and allows for the effective detection and elimination of breaches of academic integrity, incl. copyright infringement. Prior to the development of the Bachelor Thesis, students are informed that their work will be checked for plagiarism – Procedure for Reviewing Cases of Plagiarism in the Students' Graduation Papers at RTU Faculty of Computer Science and Information Technology (14 June 2019).

Guidelines concerning consideration of breaches of academic integrity and the types of plagiarism are provided in the Breach of Academic Integrity and Breach Consideration Procedures. Breaches of academic integrity are resolved by the Faculty or RTU administration on the basis of the instructor's statement – Statement of the Breach of Academic Integrity by a Student.

For the study courses implemented by BASBF, the examination and assessment procedure takes place in accordance with the Regulations of the Cabinet of Ministers of the Republic of Latvia No. 512 of 26 August 2014 "Regulations on the State Standard of Second Level Professional Higher Education", which stipulate the basic principles and basic forms of assessment of the acquisition of the program (credit test/exam), and in compliance with the Study Regulations approved by the BASBF Senate. BASBF observes the following assessment principles:

- **openness in the assessment of knowledge and skills** – in accordance with the set aims and tasks of the program, as well as the aims and tasks of the study courses, a set of requirements for positive assessment of educational achievements has been determined;
- **the principle of compulsory assessment** – it is necessary to obtain a positive assessment for the acquisition of the compulsory curriculum of the program.

The content of the examination corresponds to the content specified in the syllabus and to the skills and knowledge determined by the occupational standard. Respective assessment methods are chosen to assess students' learning outcomes.

The form (exam, credit test, assessment test) and type (oral, written or mixed) of examination are determined by the instructor. The final assessment of the study course may include the assessment of the student's performance during the study course, which is formed by the accumulation point system, i.e., the summative assessment of individual assignments. The student's independent written work may include: analytical article, student group work, individual assignment, report, case study, publication analysis, compilation and evaluation of factual materials.

Assessment criteria are included in the descriptions of study courses, which are available to each student in the Moodle system. At the beginning of the study course, the instructor introduces the students to the description of the study course, emphasizing the requirements.

At BASBF, the principles and requirements of academic integrity are stipulated in a number of binding regulations: *Code of Ethics, Study Regulations, Lecturer's Handbook, Methodological Guidelines for the Development of Study Papers*. At the beginning of the studies, the 1st year students are introduced to the principles of academic integrity within the study course "Introduction to Study Field". Detailed procedure for the prevention of plagiarism is specified in the Regulations for the Detection and Prevention of Plagiarism at BA School of Business and Finance. If the system detects signs of plagiarism, the case is reviewed by the BABSF Ethics Committee, which listens to the author, gives its opinion and, if necessary, a recommendation to the Rector on a possible sanction.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign

students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

The internship is an integral part of the professional Bachelor study program “Finance Management Information Systems”. The volume of the internship is 20 CP. The internship is divided into two parts: Part I (10 CP) in the 3rd study year and Part II (10 CP) in the 4th study year.

The internship is organized in compliance with the following guidance documents:

- Regulations of the Cabinet of Ministers of the Republic of Latvia No. 512 of 26 August 2014 “Regulations on the State Standard of Second Level Professional Higher Education”;
- Internship Organization Procedure at Riga Technical University approved at the meeting of RTU Senate on 28 January 2019 (Minutes No. 626);
- Procedure for Organizing the Internship Process at BA School of Business and Finance approved at the meeting of BASBF Senate on 18 December 2018 (Minutes No. 12);
- Qualification of software engineer within the Latvian Qualifications Framework (LQF) (https://www.latvijaskvalifikacijas.lv/en/).

The aim of internship is to enable students to strengthen their theoretical knowledge, gain experience relevant to the study program and occupational standard, as well as acquire a set of practical skills necessary for specialists of a respective field in order to perform the tasks of a software engineer at a company or within projects related to the financial sector. The duration and implementation period of the internship are determined in accordance with the study schedule. The internship is implemented in accordance with the Agreement on Providing the Student’s Internship that is entered by and between BA School of Business and Finance or Riga Technical University, the internship company and the student. The Agreement stipulates the duties and responsibilities of the parties, as well as the assessment of the internship achievements. The student undertakes internship at an organization, if during the internship the student is provided with an internship (work) place where to perform the duties of a trainee in accordance with the tasks specified in the internship program. Depending on the institution at which the student is enrolled, either BASBF or RTU is responsible for organizing the internship. The internship at RTU takes place in accordance with the Internship Organization Procedure at Riga Technical University approved at the meeting of RTU Senate on 28 January 2019 (Minutes No. 626). (For more information see Appendix P31). The Internship Organization Procedure is available at RTU website and ORTUS.

Taking into account the above-mentioned documents and the dual form of the study program implementation, BASBF and RTU have developed the Methodological Guidelines for Internship at the Professional Bachelor Study Program “Finance Management Information Systems”.

The Methodological Guidelines are available to every student in the ORTUS e-learning environment. Before the internship, an introductory meeting is organized with the head of the study program at RTU or BASBF, depending on the higher education institution at which the student is enrolled. During the meeting, students are acquainted with the internship documentation, internship organization procedure and the public presentation of the internship achievements. During the internship, students communicate with an internship coordinator at the higher education institution, as well as an internship supervisor at a company.

Based on the concluded agreement, an internship company assigns an internship supervisor at the company for the duration of the internship. The student can choose their workplace as an internship place, upon previous agreement with BASBF or Riga Technical University.

The internship schedule must be drawn up no later than one month before the start of the internship. When the internship places are selected by the students, the internship coordinator has to draw up a schedule for supervising the internship performance. The following information shall be included in the internship schedule: the volume of internship in credit points and the number of students; the period of the internship, i.e., the start date and the end date of the internship; the date and time of the student meeting; supervision dates; dates of other events (lectures, study visits, etc.), if they are planned during the internship; the submission date of the internship report; the date of public presentation of the internship report.

The student shall draw up an internship report in accordance with the approved internship program. A link to the feedback form is sent to the internship supervisor seven days before the end of the internship. A complete report must be submitted to the internship supervisor no later than three days before the end of the internship. The internship supervisor evaluates and signs the report, as well as draws up a reference on the student's performance during the internship, noting their independence in the fulfillment of tasks, attitude towards work, discipline in the workplace and the possession of the required skills. Within three days as from the end of the internship, the reports are submitted to the internship coordinator. The internship coordinator makes a decision on admitting a student to the public presentation of the internship report. The internship coordinator confirms with their signature the compliance of the internship report with the requirements specified in the Methodological Guidelines for Internship, evaluates it according to a 10-point grading scale, as well as draws up a review on the internship report.

The Council of the study program "Finance Management Information Systems" approves the Internship Evaluation Committee, consisting of at least three members: one representative of the BASBF academic staff, one representative of RTU academic staff and one representative of the company.

Within the study program "Finance Management Information Systems", the intended internship place is an IT company or an IT unit of a financial company or another company (organization) that is able to provide an internship place in the development, maintenance and/or use of computer systems or other software products closely related to finance. The internship tasks should include the duties of a software engineer, such as planning and organizing the work related to the development of software, as well as developing software according to the functionality, quality and resource intensity requirements, preparing and configuring the development environment and writing the program code in compliance with the design and programming guidelines. The internship tasks can also be related to the development of software architecture, implementation and maintenance of software, processing of error reports and analysis of the error sources, as well as organizing and performing software testing and result analysis. In addition to the above-mentioned competences of software engineer, the students undertaking internship should demonstrate skills and competences in the field of finance, which allow them to develop software products for the financial sector and work effectively in the field of their development.

Cooperation with employers at RTU is coordinated by RTU Career Center, which establishes and maintains contacts with potential employers, and advises students on professional career development. The Career Center informs about current events in the labor market, as well as about vacancies and internship opportunities in Latvia and abroad. Current vacancies are published on RTU website, under the section dedicated to the Career Center. RTU Career Center has developed a teaching aid "From Job Advertisement to the First Working Day", which helps young people to find an internship or a job.

BASBF Career Center plays a leading role in organizing cooperation with employers at BASBF. In cooperation with employers, BASBF students not only have internship opportunities, but also receive job offers. Information about vacancies is available at the BASBF information system BAIS or Career Center.

Until now, the students of the study program have undertaken internship at companies, where they have completed internship tasks closely related to the specifics of the program, i.e., work on IT projects closely related to the financial field. Companies where the internships have taken place are Swedbank JSC, Pritnful Latvia Ltd, TestDevLab Ltd, Molon Ltd, Wonderland Media Ltd, Terra Virtuala Ltd, European Organization for Nuclear Research (CERN), Switzerland).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The graduation papers have not been developed yet since the study program was launched in September 2018. In 2021, the Faculty of Computer Science and Information Technology elaborated the Methodological Guidelines for the Development of Bachelor Theses, which have to be observed by all study programs of the FCSIT.

Acquisition of the program is completed by a **state examination**, which is evaluated according to a 10-point grading system – the public presentation of the Bachelor Thesis Including Project. The evaluation criteria of the public presentation of the Bachelor Bachelor Thesis Including Project are as follows:

- systematization, updating and expansion of theoretical knowledge, practical skills and experience gained during individual and study internship;
- independent acquisition of study and scientific literature, legislation and normative acts corresponding to the chosen specialization, as well as information available in other informative sources, incl. in foreign languages;
- the ability to solve the research problem, which includes certain elements and tasks of novelty, linking it with the theoretical framework;
- problem analysis, systematization;
- the ability to present the research conducted and the practical results obtained.

A sample application for the theme of the Bachelor Thesis has been developed. The application is filled in by the student who states the topicality of the research, provides the substantiation of the theme, difines the research problem and the main research question. The student should also choose the desired scientific adviser. Applications are approved and signed by the heads of the program and the head of the Institute of Applied Computer Systems. Applications that miss required information on the theme and its substantiation are provided with comments on deficiencies, and clarifications (modifications) are requested to be made. The improved applications have to be resubmitted.

The theme of the Bachelor Thesis is chosen in the autumn semester of the 4th study year. The list of themes related to financial management in the IT sector submitted by the 4th year students in academic year 2021/2022:

- Factors Influencing the Migration of E-Commerce Platforms;
- Development of IOS Mobile Application for Getting Acquainted with RTU Sports Schedule and Registration for Sports Activities Using Students' Sports Money;
- Effective Management of Vocational Education Institutions and Improvement of Staff Competence;
- Graph Databases and their Application for Financial Crime Prevention.

As can be seen, the themes of the Bachelor Theses are specific and reflect the topical issues of financial management in the IT industry.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU and BASBF infrastructure and material and technical facilities consist of three main parts:

- premises for academic and research activities;
- library;
- IT support.

The implementation of the study program by RTU takes place in Riga, Zunda Embankment 10, and by BASBF – at Kr. Valdemāra Str. 161 and Skanstes Str. 43. A new building of RTU FCSIT located at Zunda Embarkment 10, Riga, was put into service in 2021. Students and instructors have at their disposal classrooms equipped with multimedia equipment that fully comply with the requirements set for the implementation of the study program. RTU FCSIT constantly monitors the compliance of premises and technical equipment with the quality requirements; classrooms are equipped with multimedia systems (see Section 2.3.4). All students of the program, regardless of their matriculation institution (BASBF or RTU), are offered equal opportunities to use both RTU and BASBF infrastructure, as well as material and technical resources (see Section 2.3.4). Students can use, for example, the Design Factory in Ķīpsala – Design Factory | Riga Technical University. BASBF provides classrooms with modern presentation equipment to ensure the study process. Access to the web resources is provided in all classrooms. Licensed software required for the study process is installed on classroom computers. Students have access to the materials of all study courses in the Moodle environment (part of RTU portal ORTUS and the information system BAIS of BASBF). The description of RTU ICT solutions is provided in Section 2.3.4. Students also have the right to access the information system BAIS of BASBF, which contains all the information necessary to ensure the study process, incl. normative documents, schedule, contact information of the academic and support staff, as well as current information concerning the study process. Students have e-mail addresses of both BASBF and RTU, which are used for communication with the academic and support staff of the respective higher education institution, as well as for receiving current information. Access to e-mail and other necessary resources of both higher education institutions is provided from any web address.

RTU leases “Microsoft Windows” and “Microsoft Office” software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user.

Students of the study program have free access to the Bloomberg Laboratory, located at RTU Faculty of Engineering Economics and Management. The laboratory provides students and researchers with access to extensive real-time databases, research, and analysis tools. It promotes the scientific quality and competitiveness of students and researchers in the labor market. The Bloomberg database is very extensive, covering all the world’s financial data, information on companies, securities, transactions, marketing activities, real estate and other taxes, etc. There are 12 specially equipped terminals in the laboratory, which are available to all RTU students and researchers. The laboratory has been equipped under the European Union specific support measure 8.1.1 with the aim to improve RTU study environment within the project “Development of Riga Technical University (RTU) Infrastructure for Modernisation of Science, Technology, Engineering and Mathematics (STEM) Study Programs”. The overall aim of the project is to increase the number of modernized STEM study programs.

RTU Scientific Library is available for students and academic staff. It is equipped with modern equipment and technologies and provides various services (see Section 2.3.3). Every year RTU subscribes to the most important databases of scientific articles according to the needs of the faculties. The collection is supplemented according to the recommendations of the heads of the study programs and researchers, taking into account the allocated funding (see Section 2.3.3). Databases are available to all students and academic staff members on RTU portal ORTUS – Library – Electronic Resources. Advice on using and searching databases is provided by the Information and Service Department of the Scientific Library.

BASBF students and other stakeholders have an opportunity to use the resources of the BASBF library. The library is located at K. Valdemāra Str. 161 (on the 3rd floor). It consists of a subscription and a reading room. The total area is 267 m^2. The BASBF library has more than 16000 books and other information items. The electronic catalog contains 3520 unique entries and allows searching and ordering books remotely. The library regularly receives periodicals published both in Latvia and abroad. The BASBF library subscribes to The Economist, Financial Times, etc.

The BASBF library provides access to scientific publications in electronic databases. The library subscribes to the following electronic full-text databases: EBSCO, Emerald, JSTOR and ScienceDirect. Scopus and Web of Science databases are also available, as well as archives of electronically subscribed journals and information sources developed in Latvia. The library has an electronic catalog, which is created in the integrated library system “ALISE”. The ALISE library system allows authorized users to check the status of their account, request an extension and make book reservations. The library is also a participant of the project “Virtual Joint Catalog of 11 Higher Education Institutions and Special Libraries”; therefore, the users have an opportunity to search for information in 11 libraries simultaneously. For the convenience of students, the reading room is equipped with 21 computers that have Internet access; printing and copying facilities are also available. It is also possible to use laptops. Textbooks that are required within almost all study courses, with an increasing proportion of literature in English, can be taken home. Academic staff members are regularly asked about the latest teaching aids that are necessary to be purchased to ensure the study process.

Students have wide opportunities to use the Sports Complex in Ķīpsala Campus, sports infrastructure at Meža Str. 1, Riga, and the recreation center “Ronīši” in Klapkalciems.

Specific equipment is also used for study purposes and is available centrally as well as at other faculties. The Faculty of Computer Science and Information Technology is the most important contributor, which provides classroom and auditorium computers for the study process, as well as provides all the licensed computer software necessary for the study process. The necessary computer software is available to ensure distance learning. Thus, it can be claimed that the equipment and resources available for studies are very abundant and sufficient for the study process and ensures the achievement of study results.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU and BASBF have envisaged the necessary financial resources to ensure high quality study process. Their provision is confirmed by the permanent cash balances of higher education institutions in the accounts of credit institutions, which several times exceed the financial resources of the study program, as well as the current financial situation of partner higher education institutions, which is characterized by available current financial statements. Taking into account that at RTU the study program is financed by student own funds (tuition fee of 11 200 EUR per study program, or 2 800 EUR per year), and at BASBF there are no student own funds (tuition fee of 11 200 EUR per study program, or 2 800 EUR per year), instead 13 state-funded budget positions are available. Based on the 2015 “Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation”, as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study program, RTU has determined that the professional bachelor study program must have at least 19 students in each academic year. The current economic activity and financial situation of higher education institutions allow finding funds for financing the study program, irrespective of the number of enrolled students.

RTU ensures the implementation of study programs with a smaller number of students in those study fields that are strategically important for both RTU and the state, as well as supports the new study programs during the first years of their implementation, allocating co-financing from RTU other funds. In order to ensure the efficiency of study programs with a smaller number of students, similar study courses are implemented simultaneously for students of several study programs (for example, mathematics, physics, etc.), as well as classes are planned jointly for local and foreign students, if the specifics of the study course and the language of implementation allow it, and other activities are performed that do not affect the quality of studies. The heads of study programs that receive special support due to an insufficient number of students participate in regular meetings aimed at discussing the necessary measures to be taken in order to increase the number of both local and foreign students. Information on the minimum required number of students at the program is provided in the appendix to the Self-Assessment Report “On the Minimum Number of Students at the Study Program”.

Taking into account the fact that the study program is implemented together with the BA, the actual costs from both universities are not included in the calculation of costs per student, but the theoretically necessary costs (optimal costs) are calculated, which means that the costs per 1 student of 4727.27 eur will differ significantly from other study programs.

The principles of fund distribution for the implementation of the joint professional Bachelor study program “Finance Management Information Systems” of RTU and BASBF are commonly applicable to the partner institutions irrespective of the place of student enrollment and the source of funding (income from tuition fees, transfers from the state, etc.).

Due to the fact that the matriculation of the students takes place at two universities at the same time, a sustainable funding model of the program has been developed. The funding required for the implementation of the study program consists of the following groups of expenses:

1. General administrative expenses;
2. Program administrative expenses;
3. Implementation costs of the study courses of the program;
4. Costs related to study (graduation) paper supervision and obtaining of professional qualification.

General administrative expenses

General administrative expenses (F_{ga}) are used to cover the general administrative expenses of both higher education institutions. General administrative expenses are set at 28.75% of the actual funding of the study program. General administrative expenses are equally distributed between the two higher education institutions.

Program administrative expenses

Program administrative expenses (F_{pa}) are used to cover the administrative expenses of the study program. The program administrative expenses are fixed in the amount of 2400 EUR (two thousand four hundred euros 00 cents) per year and include: the remuneration of the chairperson of the Program Council – 150.00 EUR (one hundred and fifty euros 00 cents) per month (incl. mandatory state social insurance contributions) and the remuneration of the secretary of the Program Council – 50.00 EUR (fifty euros) per month (incl. mandatory state social insurance contributions). The program administrative expenses shall be borne by the higher education institution that chairs the Program Council.

Implementation costs of the study courses of the program

RTU implements study courses in the field of information technology in the amount of 69 (sixty-nine) credit points, including free elective study courses in the amount of 4 CP. BASBF implements the field-specific study courses in the financial sector and general education study courses in the amount of 50 (fifty) credit points, including free elective study courses in the amount of 2 CP. The higher education institutions are jointly responsible for practical placement, they evaluate study projects and organize a state examination consisting of the Bachelor Thesis (a total of 40 credit points), as well as implement the study course "Introduction to Study Field" (1 credit point). According to the study course implementation costs, the values of course cost coefficient (C_{costs}) and the adjusted course cost coefficient ($C_{adjcosts}$) are determined.

Table 2

Values of the Course Cost Coefficient (C_{costs}) and the Adjusted Course Cost Coefficient ($C_{adjcosts}$)

No.	**Title of the study course**	**Type of the study course**	**Party implementing the study course**	**Volume of the study course, CP**	**Value of the course cost coefficient C_{costs}**	**Value of the adjusted course cost coefficient $C_{adjcosts}$**
1.	Law	General education study course	BASBF	2.00	1.00	2.00
2.	Environmental Protection, Civil Defense and Labour Safety Organization	General education study course	BASBF	3.00	1.00	2.00
3.	Economics	General education study course	BASBF	4.00	1.00	4.00
4.	International and Commercial Law	General education study course	BASBF	2.00	1.00	2.00
5.	Business Organization	General education study course	BASBF	2.00	1.00	2.00
6.	Mathematics	Field-specific IT study course	RTU	9.00	1.25	11.25
7.	Discrete Mathematics	Field-specific IT study course	RTU	3.00	1.25	3.75
8.	Financial Mathematics	Field-specific IT study course	RTU	2.00	1.25	2.50
9.	Physics	Field-specific IT study course	RTU	2.00	1.50	3.00
10.	Database Management Systems	Field-specific IT study course	RTU	4.00	1.5	6.00

11.	Applied Software Automation Tools	Field-specific IT study course	RTU	2.00	1.5	3.00
12.	Programming Languages	Field-specific IT study course	RTU	4.00	1.5	6.00
13.	Introduction to Study Field	*Field-specific IT study course*	RTU/BASBF	1.00	1.00	1.00
14.	Operating Systems	Field-specific IT study course	RTU	3.00	1.5	4.50
15.	Introduction to Artificial Intelligence	Field-specific IT study course	RTU	2.00	1.5	3.00
16.	Data Structures	*Field-specific IT study course*	*RTU*	3.00	1.5	4.50
17.	Banking Information Systems	*Field-specific IT study course*	RTU	3.00	1.5	4.50
18.	Algorithmization and Programming of Solutions	Field-specific professional study course	RTU	6.00	1.5	9.00
19.	Data Models of Database Systems	Field-specific IT study course	RTU	2.00	1.5	3.00
20.	WEB Technologies	Field-specific IT study course	RTU	4.00	1.5	6.00
21.	Object-Oriented Programming	Field-specific IT study course	RTU	4.00	1.5	6.00
22.	Computer Systems Engineering	Field-specific IT study course	RTU	4.00	1.5	6.00
23.	Fundamentals of Information Systems Development	Field-specific IT study course	RTU	4.00	1.5	6.00
24.	Financial Management	Fiancial sector study course	BASBF	8.00	1.50	12.00
25.	Systems Analysis and Knowledge Acquisition	Field-specific IT study course	RTU	2.00	1.5	3.00

26.	Fundamentals of Computer Systems Design	Field-specific IT study course	RTU	2.00	1.5	3.00
27.	Process-Oriented Systems Development (study project)	Field-specific IT study course	RTU	2.00	1.5	3.00
28.	Web-application Creation (study project)	Field-specific IT study course	RTU	2.00	1.5	3.00
29.	Management Accounting and Business Finance	Fiancial sector study course	BASBF	6.00	1.50	9.00
30.	Financial Mobile Application Development	Field-specific IT study course	RTU	2.00	1.5	3.00
31.	Object-Oriented Programming Practice (study project)	Field-specific IT study course	RTU	2.00	1.5	3.00
32.	Financial System Organization	Fiancial sector study course	BASBF	2.00	1.25	2.50
33.	Accounting System	Fiancial sector study course	BASBF	2.00	1.50	3.00
34.	Taxes and Audit System	Fiancial sector study course	BASBF	3.00	1.25	4.75
35.	Financial Services on the Internet	Fiancial sector study course	BASBF	4.00	1.25	5.00
36.	Risk Management in Finance	Fiancial sector study course	BASBF	2.00	1.25	2.50
37.	Computer Aided Solutions in Microsoft Programming System	Field-specific IT study course	RTU	2.00	1.50	3.00
38.	Information Systems Security	Field-specific IT study course	RTU	2.00	1.50	3.00
39.	Object-Oriented System Analysis	Field-specific IT study course	RTU	2.00	1.50	3.00

40.	Actuarial Mathematics	Fiancial sector study course	RTU	3.00	1.50	4.50
41.	Applied Financial Analysis	Fiancial sector study course	RTU	3.00	1.50	4.50
42.	Financial Markets and Investments	Fiancial sector study course	RTU	4.00	1.50	6.00
43.	Project Management	General education study course	RTU	2.00	1.25	2.50
44.	Sales Skills and Cross-Cultural Communication	General education study course	BASBF	2.00	1.00	2.00
45.	Customer Behavior in the Financial Market	Fiancial sector study course	BASBF	2.00	1.00	2.00
46.	Business German	General education study course	BASBF	2.00	1.25	2.50
47.	Business English	General education study course	BASBF	2.00	1.25	2.50
48.	Second Foreign Language (English/German)	General education study course	BASBF	2.00	1.25	2.50
49.	English for Specific Purposes	General education study course	BASBF	2.00	1.25	2.50
50.	German for Specific Purposes	General education study course	BASBF	2.00	1.25	2.50
51.	The Latvian Language*	General education study course	BASBF	2.00	1.25	2.50

RTU implements study courses in the amount of 69.50 (sixty-nine and 50/100) credit points with the value of the adjusted course cost coefficient ($C_{adjcostsrtu}$) of 100.25 (one hundred and 25/100). BASBF implements study courses in the amount of 30.50 (thirty and 50/100) credit points with the value of the adjusted course cost coefficient ($C_{adjcostsbasbf}$) 63.50 (sixty-three and 25/100). The value of the total adjusted course cost coefficient ($C_{adjcosts}$) is 163.75 (one hundred and sixty-three 75/100).

Costs related to study (graduation) paper supervision and obtaining of professional qualification

The costs related to study (graduation) paper supervision and obtaining of professional qualification

(F_{sp}) are determined for study papers, practical placement and state examination in the total amount of 40 credit points and include: the supervision and review of the Bachelor Thesis; the review of internship report; the supervision of the study projects; membership of committees; administration of the SQA qualification exam. The costs related to study (graduation) paper supervision and obtaining of professional qualification per student are stipulated as constant amounts in EUR and approved by the higher education institutions.

Revenue distribution

Revenue of higher education institutions is distributed to cover the implementation costs of the study program in the following order: first, general administrative expenses (F_{ga}) are covered, followed by program administrative expenses (F_{pa}) and costs related to study (graduation) paper supervision and obtaining of professional qualification (F_{sp}).

The funds allocated to RTU are calculated according to the formula:

$F_{rtu} = C_{adjcostsrtu} / C_{adjcosts} * 100\%$.

The funds allocated to BASBF are calculated according to the formula:

$F_{basbf} = C_{adjcostsbasbf} / C_{adjcosts} * 100\%$.

The funds intended to cover the implementation costs of the study courses of the programs are distributed between the higher education institutions as follows: RTU receives 61% (sixty-one percent) and BASBF – 39% (thirty-nine percent).

The fee for repeated or individual examinations within the study courses implemented at RTU is determined in accordance with RTU internal regulations, and the student pays the fee to RTU. If a repeated or individual examination is taken within the study courses implemented by BASBF, the student's obligations are stipulated in accordance with BASBF internal regulatory enactments, and the student pays the fee to BASBF. The received revenue remains at the disposal of each higher education institution.

Mutual settlements

Until the 20th (twentieth) day of the first month of each current study semester, both higher education institutions calculate the distribution of study funding based on the number of students enrolled in each study course. The higher education institutions pay for the study courses implemented by the partner higher education institution according to the expenses provided in Table 2.

RTU:

Academic year	Subsidy for the program, EUR	Tuition fee paid by local students, EUR	Total funding of the study program, EUR	State budget funds per student, EUR
2018/2019	-	13169,-	13169,-	-
2019/2020	-	-	-	-
2020/2021	-	14560,-	14560,-	-

BASBF:

Academic year	Subsidy for the program, EUR	Tuition fee paid by local students, EUR	Total funding of the study program, EUR	State budget funds per student, EUR
2018/2019	2443,-	16100,-	18543,-	1222,-
2019/2020	12253,-	9800,-	22053,-	2248,-
2020/2021	28092,-	12600,-	40692,-	2664,-

Information on the distribution of funding among cost items is provided in the appendix to the Self-Assessment Report “Distribution of Funding among Cost Items”.

Information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the cost per student is given in the Annex “Breakdown of funding between cost items”. Information on the minimum number of students required for the study program is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study program”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

Developing the study program “Finance Management Information Systems”, one of the most important tasks has been to provide competitive higher professional education in software engineering and finance, as well as to educate and train students for professional career at the companies in the field of finance and IT. Based on the aforementioned task and the approved curriculum of the study program, RTU and BASBF academic staff members, as well as guest lecturers, who are experts in their field, have been invited to implement the study program. A total of 22 RTU and 18 BA lecturers are involved in the implementation of the study program. RTU 19 (86.36%) lecturers have a doctoral degree. BASBF 8 (42.10%) lecturers have a doctoral degree, while 2 lecturers of the study program continue their studies in doctoral studies. RTU 20 (90.9%) and BASBF 13 (72.22%) - lecturers have a basic election place. In general, the academic staff members have appropriate qualification to ensure the high-quality study process. The instructors involved in the implementation of the study program carry out research activities, participate in various international scientific and applied projects, publish scientific papers, incl. in Web of Science and Scopus databases, as well as present their research results at international scientific conferences. (For more information see CVs of Academic Staff Members Annex P20.)

At RTU, the study process is mainly ensured by academic and technical staff of the Department of Artificial Intelligence and Systems Engineering, the Department of Software Engineering and the Department of Applied Computer Science of the Institute of Applied Computer Systems at the Faculty of Computer Science and Information Technology. In addition, the academic staff of the following organizational units of RTU are also involved:

- RTU Department of Engineering Mathematics (FCSIT);
- RTU Department of Computer Networks and System Technology (FCSIT);
- RTU Department of Probability Theory and Mathematical Statistics (FCSIT);
- RTU Institute of Technical Physics (Faculty of Materials Science and Applied Chemistry).

At BASBF, the following organizational units are involved in the implementation of the the study program:

- Department of Finance;
- Department of Entrepreneurship and Business Informatics;
- Department of Foreign Languages;
- Management Department.

The following academic staff members from **RTU** are involved in the implementation of the study program:

1. **Prof. Inta Volodko,** *Dr.math.* Field – Mathematics (Mathematical Physics). She obtained her PhD degree in Mathematics at the University of Latvia in 1995. She has been holding an elected position of Professor since 2007. She has 20 years of work experience as the Head of the Department of Engineering Mathematics and 28 years of experience in scientific work. She has 26 years of pedagogical work experience. Scientific adviser of three Doctoral Theses. Member of the Board of the Latvian Union of Scientists and Member of the Board of the Latvian Mathematical Society. She has developed several courses in mathematics, regularly participates in scientific and methodological conferences in Latvia and abroad. She undertakes teaching activities at all RTU faculties. She is the author of several textbooks, such as “Higher Mathematics” and “Elements of Probability Theory and Statistics”, etc. Currently, as a Leading Researcher, she participates in the fundamental and applied research project of the Latvian Council of Science “Analysis of Complex Dynamical Systems in Fluid Mechanics and Heat Transfer” (2020–2022). She also participated as a Leading Researcher in the fundamental and applied research project of the Latvian Council of Science “Swirl Flows: Modeling and Use in Energy Transfer Technologies, Design of New Devices, Acquisition of New Technical Solutions and Environmental Protection” (2014–2017). The qualification of Prof. I. Volodko complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Mathematics” and “Discrete Mathematics”.
2. **Prof. Māris Buiķis,** *Dr.math.* Department of Probability Theory and Mathematical Statistics. He studied applied mathematics at the Faculty of Physics and Mathematics of the University of Latvia, after studies he continued to work at the Computing Center of the University of Latvia. He completed Doctoral studies at the University of Latvia in 1972. He has experience in the development and delivery of several study courses, such as “Portfolio Theory”, “Financial Mathematics”, “The Derivative Securities”, “Analysis of Securities Portfolio”, “Actuarial Mathematics”, “Financial Risk Management”, etc. He also advised insurance companies on risk insurance calculations. He participated in the development, licensing, accreditation and implementation of RTU professional Bachelor study program “Financial Engineering”. The qualification of Prof. M.Buiķis complies with the prerequisites set for the

implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Financial Mathematics”.

3. **Prof. Juris Blūms,** *Dr.sc.ing.* Field – Physics and Astronomy. More than 20 years of experience in academic and scientific positions. Since 2019, he has been the Head of the Institute of Technical Physics of RTU Faculty of Materials Science and Applied Chemistry. He is a member of the Study Quality and Program Commission of RTU Senate, member of Finance and Budget Commission of RTU Senate, member of Promotion Council P-02. He has supervised two PhD Theses. He was a Project Manager of the fundamental and applied research project of the Latvian Council of Science “Design of Intermolecular H-Bond Structure for Stronger Triboelectification in Polymers” (1 December 2020 – 30 December 2021). Scientific articles indexed in the Web of Science and/or Scopus database are published annually. He is the author of five Latvian patents. The qualification of Prof. J. Blūms complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and the study course “Physics”.
4. **Assist. Prof. Jānis Eiduks,** *Dr.sc.ing.* Field: Electrical engineering, electronics, information and communication technologies (Systems analysis, modeling and design). In 1979, he publicly presented his PhD Thesis “Interactive Multicriteria Optimization Vector-Relaxation Methods” in the field of technical cybernetics and information theory and was awarded the degree of Candidate of Technical Sciences. In 1992, after nostrification, J. Eiduks was awarded the scientific degree of the Doctor of Engineering. For the last 17 years, the main scientific and engineering activities were related to the use of database management systems for the development of information systems. The list of developed and delivered study courses includes “Advanced Data Technologies”, “Large Databases”, “Information Systems and CASE Tools”, “CASE Tools for Database Design”, “Multidatabase Systems”, “Administration of Large Databases”, “Technology of Large Databases”, “Database Management Systems”, “Database Technologies”, etc. He is the author of 71 scientific, methodological and engineering research papers. He supervised two ERDF projects – “Design and Development of Biological Resources Research Information System (IS)” (2013–2015) and “Development of Data Warehouse Network Applications” (2006–2015). The qualification of Assist. Prof. J. Eiduks complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Financial Mathematics” “Database Management Systems” and “Data Models of Database Systems”.
5. **Lecturer Ainārs Auziņš,** *Mg.sc.ing.* Researcher in the field of electrical engineering, electronics, information and communication technologies (Systems analysis, modeling and design). In 2021, he improved his qualification within the project “Excellence in Computer Science in Latvia” at the University at Buffalo, Buffalo, the USA (the main study course / acquired professional skills: STEM Communications, Foundations of Engineering Education, Big Data, Introduction to Data Mining, DBMS). He has experience in supervising graduation papers. He is a Researcher within the ERDF project “Support for the Development of New Products and Technologies within Competence Centers”. The qualification of Lecturer A. Auziņš complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and laboratory works within the study course “Database Management System”.
6. **Assoc. Professor Aleksejs Jurenoks,** *Dr.sc.ing.* Leading Researcher and Head of RTU Department of Software Engineering. Field: Computer science and informatics (Computer and

systems software). He is an Expert of the Latvian Council of Science in the field of Engineering Sciences and Technologies, subfield – Electrical Engineering, Electronics, Information and Communication Technologies. The list of developed and delivered study courses includes “Methods of Development of Applied Software Systems”, “Modern Technologies in Software Development”, “Software of User Adaptive Interface”, “Development Methods of Applied Intelligent Software Systems”, “Applied Intelligent Systems”, etc. He has supervised more than 30 Bachelor and Master Theses. He is the author of more than 30 scientific articles. The qualification of Assoc. Prof. A. Jurenoks complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Applied Software Automation Tools”, “Programming Languages” and “Financial Mobile Application Development (study project)”.

7. **Assoc. Prof. Alla Anohina-Naumeca,** *Dr.sc.ing., Dr.paed.* Vice-Dean for Academic Affairs and Leading Researcher. Field: Computer science and informatics. She is a Contract Professor at the Norwegian University of Science and Technology, Alesund, Norway. The list of developed and delivered study courses includes “Theory of Systems and Processes”, “Methods of Systems Theory”, “Fundamentals of Artificial Intelligence”. She has supervised more than 20 Master and Bachelor Theses, as well as one PhD Thesis. She is the author of a teaching aid: Anohina-Naumeca, A. Concept Map-Based Formative Assessment of Students” Structural Knowledge: Theory and Practice. Cambridge: Cambridge Scholars Publishing, 2019. A. Anohina-Naumeca is a coordinator from Latvia and researcher within six ERASMUS+ projects, field expert and coordinator at three ESF projects. She undertook an internship at the State University of New York at Buffalo, the USA. She is a member, co-chairperson and reviewer of the Program Committee of more than 20 scientific conferences. She is a member of the Editorial Board of the International Journal of Intelligent Systems and Applications in Engineering and a reviewer at other scientific journals. A. Anohina-Naumeca regularly presents research results at international scientific conferences and publishes her scientific papers in scientific journals. The qualification of Assoc. Prof. Alla Anohina-Naumeca complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Introduction to Study Field”.
8. **Prof. Marina Uhanova,** *Dr.sc.ing,* Leading Researcher. She is an Expert of the Latvian Council of Science in the field of Natural Sciences, subfield – Computer Science and Informatics. The list of developed and delivered study courses includes “Algorithmization and Programming of Solutions”, “Programming Languages”, “Special Data Processing Technologies”, “Functional Programming”, “Applied Software”, etc. She has supervised one PhD Thesis and more than 30 Bachelor and Master Theses. She participated as a Leading Researcher at the ERDF project “Methods and Tools for the Design in Reconfigurable Environment” (1 April 2018–22 February 2020). M. Uhanova regularly presents research results at international scientific conferences and publishes her scientific papers in scientific journals. She undertook an internship at the University at Buffalo, the USA (2019). The qualification of Prof. M. Uhanova complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Algorithmization and Programming of Solutions”.
9. **Assist. Prof. Imants Gorbāns,** *Dr.sc.admin.* Researcher at the University of Latvia. He has experience in the supervision of graduation papers. At the University of Colorado (the USA), he acquired the knowledge and skills related to Windows Server Management and Security, Linux Server Management and Security, Advanced System Security Topics, Cybersecurity and the Internet of Things. The qualification of Assist. Prof. I. Gobrāns complies with the

prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Operating Systems”.

10. **Lecturer Oksana Zavjalova.** Field: Electrical engineering, electronics, information and communication technologies (Systems analysis, modeling and design). She is a member of the Organizing Committee of the Joint International Conference on Engineering Education & International Conference on Information Technology (ICEE/ICIT-2014 Riga). She has experience in developing study courses and supervising Bachelor Theses. O. Zavjalova regularly publishes her scientific articles that are included in Scopus and Web of Science databases. The qualification of Lect. O. Zavjalova complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and laboratory works within the study course “Algorithmization and Programming of Solutions”.
11. **Prof. Jānis Grundspeņķis,** *Dr.habil.sc.ing.,* Leading Researcher. He is a Chairperson of RTU Promotion Council P-07. He is a full member of the Latvian Academy of Sciences. He is an Expert of the Latvian Council of Science in the field of Natural Sciences, subfield – Computer Science and Informatics. He has held various leading positions at RTU for the past thirty years. In 1972, he publicly presented his PhD Thesis “Application of Topological Properties of Complex System Models in Diagnostics” in the field of technical cybernetics and information theory and was awarded the degree of Candidate of Technical Sciences. In 1992, after nostrification, J. Grundspeņķis was awarded the scientific degree of the Doctor of Engineering. In 1993, after public presentation of a set of published works on the topic “Structural Modeling of Complex Technical Systems in the Conditions of Incomplete Information”, he was awarded a scientific degree of Habilitated Doctor. At present, his research focuses on knowledge acquisition and representation issues, in particular, on the automation of knowledge base design. He participated as a Researcher at ERA-NET Project “Changing Robotics Paradigms for the Development of Future Collaborative Robots (RoboCom ++)” (2017–2020). He has supervised 7 PhD Theses. The total number of publications is 299, of which 73 are Scopus indexed publications. The researcher has an h-index of 8. He is an associate member of several international organizations. The qualification of Prof. J. Grundspeņķis complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and the study course “Introduction to Artificial Intelligence”.
12. **Assoc. Professor Natālija Prokofjeva,** *Dr.sc.ing.,* Leading Researcher at the Department of Software Engineering. She has developed and delivered various study courses, such as “Algorithmization and Programming of Solutions”, “Modern Programming Languages and Platforms”, “Data Structures and Algorithms”, etc. She has supervised more than 80 graduation papers within the Master, Bachelor and first level professional studies. The qualification of Assoc. Prof. N. Prokofjeva complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Data Structures” and “Web-application Creation (study project)”.
13. **Assoc. Prof. Pāvels Rusakovs,** *Dr.sc.ing.* He has developed and delivered such study courses as “Concurrent Processes and ADA Language”, “PROLOG and Logical Programming”, “WEB Technologies”, “Distributed Data Processing in Computer Networks”. He has supervised more than 120 graduation papers within the Master, Bachelor and first level professional studies, as well as one PhD Thesis. The topics of scientific publications overlap with the study courses delivered and graduation papers supervised at RTU, and include such areas as programming languages, computer graphics and web technologies, etc. He is a

member and reviewer of the International Editorial Board at the International Journal on Information Technologies and Security (IJITS) and the Journal of Applied Computer Systems. The qualification of Assoc. Prof. P. Rusakovs complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “WEB Technologies”.

14. **Assoc. Prof. Gundars Alksnis,** *Dr.sc.ing.,* Head of the Department of Applied Computer Science. He led a programming school “.NET Bootcamp” (Accenture). In 2008, he publicly presented his PhD Thesis “Application of Category Theory to Integrate Formal Specification Languages in Model Driven Architecture”. He has developed and delivered such study courses as “Methods and Evolution Trends of Applied Computer Science”, “Computer Organization and Assembly Language”, “Object-Oriented Programming in Controlled Architecture”, etc. He is a member of the State Examination Commission at RTU FCSIT Institute of Applied Computer Systems. He has experience in supervising and reviewing the graduation papers. He is a member of the Association of Computing Machinery and the IEEE Computer Society. G. Alksnis is a reviewer of the Journal of Applied Computer Systems. He regularly participates in international scientific and methodological conferences. The qualification of Assoc. Prof. G.Alksnis complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Object-Oriented Programming”.
15. **Lecturer Aigars Riekstiņš,** *Mg.sc.ing.,* PhD candidate. Researcher at the Institute of Computer Control, Automation and Computer Engineering. He has developed and delivered such study courses as “Network Security”, “Computer Networks”, “Computer Systems Engineering”, etc. The qualification of Lecturer A. Riekstiņš complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Computer Systems Engineering”.
16. **Prof. Mārīte Kirikova,** *Dr.sc.ing.* She is a Leading Researcher at RTU, as well as a Leading Researcher and Visiting Lecturer at the University of Gdańsk, Gdańsk, Poland. She is an Expert at Lursoft IT Ltd (Latvia). She is an Expert of the Latvian Council of Science in the field of Engineering Sciences and Technologies, subfield: Electrical Engineering, Electronics, Information and Communication Technologies (Systems Analysis, Modeling and Design). She has developed and delivered such study courses as “Process-Oriented Systems Development (study project)”, “Toolbox of Computer Systems Development Tools”, “Project Quality Management”, “Methodologies of Information Systems Development”, “System Engineering”, etc. She has supervised 2 PhD Theses and more than 50 Master and Bachelor Theses. She led several ERASMUS and other international projects. M. Kirikova is a Leading Researcher and Project Manager from RTU at the following ERDF projects: “Comparative Analysis of Regulatory Enactments and Financial Data of Companies from Different Countries for Forecasting Business Results”; “Development of a Prototype to Ensure the Fulfillment of Responsibilities of Control Services and Financial Regulators, as well as Management of Private Sector Client Portfolios”; “Development of Data Processing Algorithm Flow Optimization Model for Identification of Politically Significant Persons”, etc. She has also participated in the National Research Program and basic and applied research projects. She is the author of 250 publications, of which 143 are included in the SCOPUS database and 65 – in the WoS database. She is a member of the Organizing Committee of many international conferences, co-chairperson of the Program Committees, member of the Steering/Advisory Committee. The researcher has an h-index of 8. The qualification of Prof. M. Kirikova complies with the prerequisites set for the implementation of the study program and the requirements

of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Systems Analysis and Knowledge Acquisition” and “Fundamentals of Computer Systems Design”.

17. **Prof. Oksana Ņikiforova,** *Dr.sc.ing.,* Leading Researcher. She is an Expert of the Latvian Council of Science in the field of Engineering Sciences and Technologies, subfield: Electrical Engineering, Electronics, Information and Communication Technologies (Systems Analysis, Modeling and Design). She has developed and delivered the following study courses: “Object-Oriented System Analysis”, “Object-Oriented System Analysis and Design”, “Software Evolution Technologies”, etc. She is the author of more than 130 scientific publications. She has led and participated in scientific projects and software development projects. She also participates as an Expert in information system audits. She is a member of various academic and industrial associations. She is involved in the organization and management of conferences, workshops, seminars. She is a Co-Editor-in-Chief of the scientific journal “Applied Computer Systems”. Prof. O. Ņikiforova is a member of the Steering Committee of the two EU COST Actions. She has supervised 5 PhD Theses and more than 50 Master and Bachelor Theses. The qualification of Prof. O. Ņikiforova complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Object Oriented Programming Practice (study project)” and “Object Oriented System Analysis”.
18. **Guest Lecturer Vadims Žuravļovs,** *Dr.sc.ing.* Researcher. He is an Expert at Accenture Latvia. He has developed and delivered such study courses as “Operating Systems”, “Software Metrology and Planning Models”, etc. He has experience in supervising the graduation papers. The qualification of Assist. Prof. V.Žuravļovs complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course “Information Systems Security”.
19. **Prof. Andrejs Matvejevs,** *Dr.sc.ing.,* Leading Researcher. He has been involved in the development, improvement and administration of the academic Master study program “Financial Engineering Mathematics” and the professional Bachelor study program “Financial Engineering”. He has development and delivered the following study courses: “Risk Management Mathematical Methods”, “Stochastic Analysis of Securities Trading”, “Applied Financial Analysis”, “Actuarial Mathematics”, etc. He has supervised many Bachelor and Master Theses, as well as one PhD Thesis. Prof. A. Matvejevs regularly presents the research results at international scientific conferences and publishes his research articles in scientific journals. He is a co-author of RTU patent “Method for Measurement of Nanoacceleration of a Body in Diluted Gas Envirronment and Device therefor” LV14575B. The qualification of Prof. A. Matvejevs complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses “Actuarial Mathematics” and “Applied Financial Analysis”.
20. **Prof. Ingars Eriņš,** *Dr.oec.,* Leading Researcher, RTU Vice-Rector for Finance, member of the Audit Advisory Council of the Ministry of Finance of the Republic of Latvia. He has been a Research Manager of the ERDF Support Operational Program “Growth and Employment”, specific support objective 1.1.1 “To Increase the Research and Innovation Capacity of Latvian Research Institutions and their Ability to Attract External Funding by Investing in Human Resources and Infrastructure” within measure 1.1.1.2. “Support for Postdoctoral Research” (2019–2021). Several study courses in the field of finance have been developed and taught. Prof. I. Eriņš has also experience in supervising the graduation papers. He is a Project Manager and a member of the Monitoring Committee within several ERDF projects, such as

"Development of a Prototype to Ensure the Fulfillment of Responsibilities of Control Services and Financial Regulators, as well as Management of Private Sector Client Portfolios", "Development of Data Processing Algorithm Flow Optimization Model for Identification of Politically Significant Persons", etc. He regularly publishes scientific articles and presents the results of research on topicalities in the banking sector, e.g., Review of Decentralized Finance Applications and their Total Value Locked. TEM Journal, 2021, 10 (1); Assessment of Blockchain-Based Professional Growth Data Processing Model, the 4th International Conference on Business and Information Management (ICBIM 2020), Italy, Rome, 3–5 August 2020; Application of Tagging Services for Term Analysis on Visual Plane in Financial Engineering. Procedia – Social and Behavioral Sciences, 2016, vol. 231, etc. The qualification of Prof. I. Eriņš complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study courses "Banking Information Systems" and "Introduction to Study Field".

21. **Assoc. Prof. Konstantins Kozlovskis,** *Dr.oec.* In 2008, after public presentation of the PhD Thesis "Strategies for Managing Financial Investments of Small and Medium-Sized Investors in the Conditions of Globalization", he obtained a scientific degree of the Doctor of Economics. Since 2001, he has been working at RTU Faculty of Engineering Economics and Management. Pedagogical experience at RTU is 19 years. Pedagogical activity includes supervising the Bachelor and Master Theses, delivering field-specific study courses and developing their syllabi. The main specialization is related to the interdisciplinary field based on financial investment management, analysis of financial instruments, statistics, econometrics and data science. In 2017, he was elected an Associate Professor. He is an Expert of the Latvian Council of Science in the field of Economics and Business (term of office until 2023). The results of scientific research activities are presented in the scientific articles (a total of 33; in the period of 2013–2019, 10 papers were published), as well as in teaching and methodological aids (a total of 12; in the period of 2013–2019, four teaching aids were developed). Since 2005, K. Kozlovskis has participated in seven projects of different levels (one RTU funded project; two projects funded by the Ministry of Education and Science and RTU; one project of the Latvian Council of Science; two ESF projects; one project of the National Research Program). The researcher has an h-index of 4 (a total of 14 Scopus-indexed articles) and WoS index of 1 (a total of 8 WoS-indexed articles). The qualification of Assoc. Prof. K. Kozlovskis complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course "Financial Markets and Investments".
22. **Assist. Prof. Rita Greitāne,** *Dr.oec.* She has more than 20 years of experience in higher education, research and project development. Every year she improves her qualification in the field of project management, marketing and communication. She has mastered the basics of coaching and the acquired knowledge is used in the academic environment, i.e., delivering the study courses and supervising the Master Theses. R. Greitāne has participated in academic conferences, presenting the reports "Current Issues in Marketing and Strategic Management: Organizational and Methodological Challenges", "Quality Assurance of Study Programs and Courses in the Field of Leadership and Management". The qualification of Assist. Prof. R. Greitāne complies with the prerequisites set for the implementation of the study program and the requirements of regulatory enactments, as well as ensures the achievement of the aims and learning outcomes of the study program and study course "Project Management".

Industry experts are also invited to share their experience on certain topics that supplement the study courses. In November 2021, Ingrīda Kikuste (Accenture Latvia) delivered a lecture “Business Requirements Documentation” in the amount of 2 academic hours within the study course “Object-Oriented System Analysis”. Study courses in English can be provided either by the responsible lecturer or by the lecturer who implements the study course. In case of non-compliance, the instructors will be offered to improve their knowledge of English at RTU courses, or other instructors with the required competence in a respective field and the appropriate level of English will be invited to participate in the implementation of the study program.

Professional development of academic staff takes place through their participation in conferences and seminars, attendance of various courses, engagement in scientific and applied research projects, as well as implementation of practical work as consultants. Every year, academic staff members actively participate in methodological seminars organized by RTU and other higher education institutions.

The following academic staff members from **BASBF** are involved in the implementation of the study program:

1. **Prof., Leading Researcher Inese Mavļutova,** *Dr.sc.admin.* Within the study program, she delivers the study courses “Management Accounting and Business Finance” and “Financial Management”. At BASBF, she delivers financial management, financial analysis, strategic financial management courses, develops methodological materials, supervises Bachelor, Master and PhD Theses. She is actively involved in international projects as a Project Manager and a Leading Researcher. She also leads research groups. During the last 5 years, Prof. Inese Mavļutova published 27 scientific articles in peer-reviewed journals, incl. articles indexed in Scopus, Web of Science, and ERIH PLUS databases. She has participated in more than 30 scientific conferences, as well as in scientific projects of the Latvian Council of Science, BASBF, ERASMUS +, ESF, EEA and Copernicus.
2. **Assoc. Prof. Jānis Strautmanis,** *Dr.sc.admin.* Head of the Department of Management at BASBF. Within the study program, he delivers the study courses “Law”, “International and Commercial Law”, and “Sales Skills and Cross-Cultural Communication”. The study courses are delivered in close cooperation and jointly with industry professionals. Jānis Strautmanis has a long-standing administrative experience in the field of education and public administration, holding leading positions at Sigulda City Council and Sigulda District Council. Jānis Strautmanis is a long-standing Chair and Senator of the Constitutional Assembly at BASBF.
3. **Assoc. Prof. Natālija Cudečka-Puriņa,** *Dr.sc.admin.* She delivers the study course “Environmental Protection, Civil Defense and Labor Safety Organization” within the study program. Natālija Cudečka-Puriņa is an expert of the Latvian Council of Science. At Liepaja University, she delivers the study course “Ecodesign and Circular Economics”. She holds the position of the Head of the Environmental Quality and Waste Management Division at the Ministry of Environmental Protection and Regional Development. During the last 5 years, Assoc. Prof. Natālija Cudečka-Puriņa published 13 scientific articles in peer-reviewed journals, incl. articles indexed in Scopus and Web of Science databases, as well as delivered presentations at 10 scientific conferences.
4. **Assist. Prof. Biruta Dzērve,** *Dr.oec.* Vice-Rector for Studies and Research at BASBF. Within the study program, she delivers the study course “Taxes and Audit System”. Biruta Dzērve is a long-standing instructor at BASBF study program “Finance”, within which she delivers study courses related to the field of taxation. She has a long-standing administrative experience as the Head of the study program “Finance” at BASBF, as well as 10 years of professional experience at the State Revenue Service of Riga branch and the State Social Insurance Board of Riga District. Biruta Dzērve publishes scientific articles and participates in scientific

conferences with reports that are closely related to the professional field of studies.

5. **Assist. Prof. Aivars Spilbergs,** *Dr.oec.* Head of the Department of Economics and Finance at BASBF. Within the study program, he delivers the study course "Risk Management in Finance". At BASBF, he delivers the following study courses: "Financial Modeling and Forecasting", "Research Methods in Financial Management", "Bank Management and Risk Management", "Financial Econometrics", "Investment Funds". He development and regularly updates teaching aids and methodological materials. Aivars Spilbergs supervises Bachelor, Master and PhD Theses. Apart from the academic activities, he also performs administrative activities and research work. During the last 3 years, he published 24 articles in scientific journals, incl. articles indexed in Scopus database, as well as participated in 17 scientific conferences. He has participated in research projects of the Latvian Council of Science, BASBF and SEB. Aivars Spilbergs has a long-standing experience in the banking sector in general and in the field of risk management in particular at one of the leading commercial banks in Latvia.
6. **Assist. Prof. Jekaterina Kuzmina,** *Dr.sc.admin.* Within the study program, she delivers the study course "Financial Management". At BASBF, she delivers the following study courses: "Corporate Finance Management", "Consumer Behavior in the Financial Market", "Sustainable Finance", "Contemporary Research in Finance". Assist. Prof. Jekaterina Kuzmina has a long-standing experience in the financial sector, including in leading positions at the financial institutions in Latvia. At present, she holds a position of a Financial Market Analyst/ Sustainable Investment Specialist at CBL Asset Management. During the last 5 years, Assist. Prof. Jektaterina Kuzmina published 9 scientific articles in peer-reviewed journals, incl. articles indexed in Scopus database, as well as participated in 17 scientific conferences.
7. **Assist. Prof. Jānis Bērziņš,** *Dr.oec.* Within the study program, he delivers the study course "Economics". Jānis Bērziņš works as a Senior Researcher at the Center for Security and Strategic Research of the Latvian National Defense Academy. Jānis Bērziņš is a Non-Resident Research Fellow and Senior Adviser at the Swedish Defense University, as well as a Senior Associate at the New Generation Warfare Center. Jānis Bērziņš worked as an Expert within the Horizon 2020 Marie Skłodowska-Curie Individual Fellowship Program (H2020-MSCA-IF) 2020 and as a Researcher/Expert within the NATO/CSO project SAS-161 "Military Aspects of Countering Hybrid Warfare: Experience, Lessons, Best Practices" (2020). Assist. Prof. Jānis Bērziņš is the author of 4 books and 14 scientific articles; he has presented the results of scientific research at 25 scientific conferences.
8. **Assist. Prof. Andris Fomins,** *Dr.oec.* Head of the study program "Finance Management Information Systems". Within the study program, he delivers the study courses "Financial System Organization" and "Financial Services on the Internet". At BASBF, he delivers the following study courses: "Financial Services", "Securities Market and Investment Funds", "International Finance and Currency Market", "Financial Markets", "Introduction to Finance". During the last 6 years, he published 6 articles in scientific journals, incl. articles indexed in Scopus database, as well as participated in 6 scientific conferences. He also took part in the research project of BASBF in the field of finance. Andris Fomins has more than 10 years of experience in the banking sector in general and in the field of operational management in particular at one of the leading Latvian commercial banks and leasing companies.
9. **Assist. Prof. Kristaps Lešinskis,** *Mg. oec.* Within the study program, he delivers the study course "Business Organization". Kristaps Lešinskis is a member of the Terminology Commission of the Latvian Academy of Sciences (LAS), as well as the Head of the LAS Economics Term Subcommittee, a board member and founder of the Latvian Association of Economists, and a member of the Latvian Association of Statisticians. During the last 5 years, Kristaps Lešinskis published 6 scientific articles in peer-reviewed journals, incl. articles indexed in ERIH PLUS, Thomson Reuters and Web of Science databases, as well as

participated in 5 scientific conferences. He also took an active part in the research grant project of BASBF and Erasmus+ KA2 Knowledge Alliance program KABADA/Knowledge Alliance of Business Idea Assessment: Digital Approach project; Project No. 612542-EPP-1-2019-1-LV-EPPKA2-KA.

10. **Assist. Prof. Gunta Innuse,** *Mg.oec.* Within the study program, she delivers the study courses “Accounting System” and “Management Accounting and Business Finance”. She has a long-standing experience in delivering these thematic study courses at BASBF (since 2003). Gunta Innuse has been the Head of the study program “Finance” at BASBF for 10 years, and the thematic area of this study program is directly related to the study courses implemented within the joint study program. During the last 5 years, she published 5 articles in scientific and professional journals, as well as presented research results at 10 scientific conferences.
11. **Assist. Prof. Sandra Ozoliņa,** *Mag.philol.* Head of the Department of Foreign Languages at BASBF. Within the study program, she delivers the study courses “Second Foreign Language”, “Business German” and “German for Specific Purposes”. Sandra Ozoliņa is a member of the Association of German Language Teachers and a member of the Deutsche Auslandsgesellschaft, as well as a German language teacher at the Goethe Institute in Riga.
12. **Assist. Prof. Astrīda Ģēgere-Zetterstroma** *Mag.philol.* Within the study program, she delivers the study course "Latvian language" for foreign students. Astrīda Ģēgere-Zetterstroma has been teaching English since 1984 and has been an English lecturer at the BASBF since 1993. Astrīda Ģēgere-Zetterstroma takes an active part in the ERASMUS + training program and is also the author of several publications, incl. WOS and SCOPUS.
13. **Lecturer Māris Krastiņš,** *Mg.oec.* Head of the Study Program “Risk Management and Insurance” at BASBF. Within the study program, he delivers the study course “Financial Services on the Internet”. At BASBF, he delivers the following study courses: “Fundamentals of Risk Management”, “Insurance” and “Insurance Products”. Māris Krastiņš has more than 10 years of practical experience in leading positions at product and property insurance divisions of Latvian insurance companies. During the last 3 years, he published 4 articles in scientific journals and participated in 6 scientific conferences, as well as was actively involved in various research activities and projects, such as “Partnerships to Ensure Risk Management Practice”, which won the prestigious EU David Gillingham Award as the best project.
14. **Lecturer MBA Ieva Kozlovska.** Within the study program, she delivers the study course "Taxes and the audit system". Ieva Kozlovska is a lecturer in several study courses at BASBF with significant practical experience in the field of auditing. Currently, she is a team leader at Ernst & Young's Audit Services Center of Excellence and is also an expert at the Academic Information Center. In the academic field, Ieva Kozlovska also works as a guest lecturer at Hochschule Helbronn. Previously, Ieva Kozlovska has worked in the examination committee of the Latvian Association of Certified Public Accountants, as a lecturer at RTU Riga Business School, foreign universities and the Applied Information Service. Currently, Ieva Kozlovska is continuing her BASBF doctoral studies. In the last 5 years, Ieva Kozlovska has published 3 scientific publications and presented at 9 scientific conferences.
15. **Lecturer Gaļina Zapletņuka,** *Mg.sc.ing.* Within the study program, she delivers the study courses “Business English”, “Second Foreign Language” and “English for Specific Purposes”. Gaļina Zapletņuka holds the Cambridge RSA Certificate in English Language Teaching to Adults (CELTA) and the London Chamber of Commerce and Industry (LCCI) Foundation Certificate for Teachers of Business English, which attest her qualification for teaching English as a foreign language. She is familiar with the programming languages CSS / HTML / Java / Objective C / Javascript / C++. The Master of Science (MSc) degree in Computer Science obtained at the University of London, Birkbeck College and professional knowledge of computer science enable G. Zapletņuka to develop students’ terminological competence and the English language proficiency in the respective field.

16. **Guest Lecturer Elīna Putniņa,** *Mg.oec.* She is the Director of the Tax Department at Deloitte Latvia Ltd, as well as a member of the Board of the Latvian Association of Tax Advisers. Within the study program, she delivers the study course “Taxes and Audit System”. E. Putniņa’s considerable professional experience in the fields of taxation and auditing provides opportunities for the students of the program to get acquainted with the practical aspects of these fields.
17. **Guest Lecturer Marta Urbāne,** *Dr.iur.,* Mg, Sc, administr. She is Sworn Advocate, Certified Mediator, Head and Lecturer of the Master's Study Program “International Business and Law at the University of Latvia” teaches the study course “International Law and Commercial Law”, providing knowledge about the study course topics and their application in practical business. During the last 5 years, Marta Urbāne has published 5 publications in scientific and professional journals, as well as presented papers at 6 scientific conferences.
18. **Guest Lecturer Sniedze Šreibere,** *Mg.iur.* She is a Lawyer at Vippharma Ltd and Briz Ltd. Within the study program, she delivers the study course “Law”, providing basic knowledge about the themes of the study course and their application.

The qualifications of the academic staff involved in the implementation of the study program "Financial Management Information System" meet the requirements of Article 55(3) of Law on Higher Education Institutions. No less than five professors and associate professors, who have been elected to academic positions at Riga Technical University, participate in the implementation of the compulsory part and the limited optional part of the academic study programs.

The qualifications of professors and associate professors comply with the regulations for the election of professors and associate professors of the Riga Technical University, adopted in accordance with the first paragraph of Article 15 of the Law on Higher Education Institutions.https://www.rtu.lv/writable/public_files/RTU_rtu__profesoru_un_asocito_profesoru_ievlanas_krtba_30.11.2015..pdf (only in Latvian)

The qualifications of docents, lecturers and assistants comply with the regulations for the election of docents, lecturers and assistants of Riga Technical University, adopted in accordance with the first part of Article 15 of the Law on Higher Education Institutions.https://www.rtu.lv/writable/public_files/RTU_rtu_docentu_lektoru_un_asistentu_ievlanas_krtba.pdf (only in Latvian)

The proportion of academic staff involved in the implementation of the study program with a doctorate degree is in accordance with the Law on Higher Education Institutions.

Study program on both the use of financial systems and the development, implementation and maintenance of such systems. Therefore, the qualifications and work experience of teaching staff both in applied and scientific projects, as well as work experience in the industry (IT and Finance) help to achieve the study results of the program.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, there have been no significant changes in the composition of the academic staff involved in the implementation of the study program.

The implementation of the study program is mainly ensured by the academic staff of RTU and BASBF in accordance with their main research activities.

The main task of RTU administrative units is to provide field-specific professional and compulsory engineering study courses aimed at development of the skills required for the qualification of a software engineer.

The main task of BASBF is to ensure the acquisition of knowledge of the financial sector and economics, which can be used to develop modern information systems for the automation of financial sector operations and increase the efficiency of financial management in other sectors of the national economy.

Changes in the Composition of RTU Academic Staff Involved in the Implementation of the Study Program

2018/2019		**2021/2022**	
	Number		Number
Professor	10	Professor	8
Assoc. professor	3	Assoc. professor	6
Assist. professor	3	Assist. professor	4
Lecturer	-	Lecturer	3
Researcher	-	Researcher	1
Acting professor	2	Acting professor	1
Total:	18	Total:	23

The field-specific professional study courses are mostly delivered by the academic staff of the departments of the Institute of Applied Computer Systems. Their composition has undergone relatively small changes.

At the Department of Artificial Intelligence and Systems Engineering (at the beginning of the reporting period it was called the Department of Systems Theory and Design):

- In place of Prof. Jānis Grundspeņķis, the instructor responsible for the study course “Introduction to Study Field” is Assoc. Prof. Alla Anohina-Naumeca, and the study course is delivered by Prof. Ingars Eriņš at RTU and Assist. Prof. A. Fomins at BASBF;

At the Department of Computer Control and Computer Networks:

- In place of Prof. Valērijs Zagurskis, the study course “Computer Systems Engineering” is delivered by Lecturer Aigars Riekstiņš;

At the Department of Software Engineering:

- In place of Prof. Eleonora Latiševa, the study course “Operating Systems” is delivered by Prof. Marina Uhanova;
- In place of Prof. Larisa Zaiceva, the study course “Programming Languages” is delivered by Assoc. Prof. Aleksejs Jurenoks.

RTU Faculty of Materials Science and Applied Chemistry, Department of Semiconductor Physics:

- In place of Prof. Artūrs Medvids, the study course “Physics” is delivered by Prof. Juris Blūms.

There are several reasons for these changes:

1. Associate professors and assistant professors have raised their qualification during the reporting period and become professors and associate professors, respectively;
2. To promote the introduction of the latest technologies in the study courses, new specialists in the field, such as lecturers and researchers, have been attracted to implement the study program. New highly qualified academic staff members are involved in the implementation of the program, thus bringing the content of the program as close as possible to the specifics and current events of the field;
3. Several industry experts have been attracted to deliver the study courses.

The policy of selection, renewal and professional development of the academic staff is based on the regular involvement of Master students, Master degree holders and PhD students in the study process, which promotes the introduction and adoption of new teaching methods, as well as linking the study process with their scientific research.

RTU is currently implementing the ESF project, special aid objective 8.2.2 “To Strengthen the Academic Staff of Riga Technical University in Strategic Specialization Areas” intended to renew the academic staff. The aim of the project is to strengthen the academic staff of RTU in ten strategic specialization areas. Project activities are focused on:

- involvement of PhD students in academic work at RTU;
- attraction of foreign academic staff to work at RTU;
- improvement of the professional competence of the academic staff, including undertaking internship at a company.

Within special aid objective 8.2.2, specialised English language courses are also provided to the academic staff. The academic staff stability is positively valued. It should be noted that academic staff members regularly participate in various professional development activities. Professional development of academic staff takes place by their participation in conferences and seminars, attendance of various courses, as well as engagement in scientific and applied research projects. The knowledge gained during professional development and research activities is incorporated into the study process. The academic staff of the program participate in local and international conferences, the information on which is provided in their CVs.

The academic staff involved in the implementation of the study program not only have relevant academic education to deliver the respective study courses, but also have extensive professional experience. To provide students with an in-depth understanding of the practical application of knowledge, 4 instructors, who do not have a full-time job either at BASBF or RTU, but who are specialists and experts in their field, are also involved in the implementation of the study program.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The interrelation of study courses and their logical and sequential acquisition play an important role in the achievement of the learning outcomes of the study program. The academic staff members cooperate on a daily basis in various issues related to the study process. In the process of study course development, the academic staff members mutually agree on the curriculum of study courses among themseleves and with the head of the study program both within RTU and between RTU and BASBF, which ensures non-overlapping of content and the logical interconnection between the courses. As the program is new, the study courses are improved based on the feedback from students and academic staff of both higher education institutions. Taking into account the dynamic nature of the IT industry, the recommendations of industry experts are essential to ensure the interrelation of study courses. Based on the industry experts' recommendations, such study courses as "Project Management", "Financial Markets and Investments" have been included, the study course "Applied Software" has been replaced with the study course "Applied Software Automation Tools", the study course "Technology of Large Databases" has been excluded and the study course "Data Models of Database Systems" has been included in the study program.

In the study process, regular instructors' meetings and methodological seminars are organized, where the exchange of experience on the topics of the study courses takes place, as well as the curricula of the study courses are developed and improved by mutually agreeing on the topics, areas, responsibilities and complying with the regulatory requirements. When planning the academic year and agreeing on the tasks of the study projects, the previously identified shortcomings are taken into account and the necessary changes are made. Thus, it can be stated that a mechanism for mutual cooperation of academic staff has been developed, which promotes the improvement and interrelation of study courses.

Analyzing the student – instructor ratio at the time of submitting the Self-Assessment Report, there was one elected RTU instructor at the program for 0,86 students and one industry specialist for 7,75 students. Such a ratio of academic staff and students is not correct, because in the planning process of the study process the study courses were combined with the study courses of other study programs, where the number of students was significantly higher. The calculation did not take into account the BASBF academic staff involved in the implementation of the study program.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DCP0(42484)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DCP0(42484)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)	P04_DCP0(42484)_Ligums un pielikumi.zip	P04_DCP0(42484)_Ligums un pielikumi.zip
Statistics on the students in the reporting period	P05_3.1.4_DCP0(42484)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DCP0(42484)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DCP0(42484)_CompliancewiththeStateEducationStandard_ProfBak_ENG.pdf	P06_3.2.1_DCP0(42484)_AtbilstibaValstsStandartam_ProfBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_DCP0(42484)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf	P07_3.2.1_DCP0(42484)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DCP0(42484)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DCP0(42484)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DCP0(42484)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DCP0(42484)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DCP0(42484)_StudyCoursesdescr_ENG.zip	P10_DCP0(42484)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_DCP0(42484)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_DCP0(42484)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Digital Humanities (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Digital Humanities*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Marina*
Surname of the study programme director	*Platonova*
E-mail of the study programme director	*marina.platonova@rtu.lv*
Title of the study programme director	*Dr.philol.*
Phone of the study programme director	*29417540*
Goal of the study programme	*• To educate specialists in digital humanities whose knowledge and skills meet the demands of the contemporary labour market and research-intensive economy and who are able to work in state and municipal institutions of Latvia and after acquiring additional qualification in the institutions of the EU, as well as in private enterprises in Latvia and abroad; • To implement an open and flexible student-cantered study process that would ensure the integration of the latest information technologies in humanities (in the broadest sense of this term) and advanced mastering of the theoretical basis of the chosen scientific and technical field; • To expand and develop students' engineering, linguistic, socio-cultural, technical, creative, and research skills for independent work in the field of digital humanities; • To develop students' academic and research skills to ensure they develop the necessary level of competence and skills that would give them an opportunity to continue their studies at the PhD study programs and to motivate them to conduct research in digital humanities; • To develop students' independence, initiative, as well as an ability to adapt to the constantly changing environment.*

Tasks of the study programme	*• To provide students with competitive master level education in the field of digital humanities in compliance with the national and international standards;* *• To provide students with the necessary theoretical knowledge as well as the body of practical skills and competences required in order to perform high-level programming, multimodal data processing, development and application of applied software, interdisciplinary semiotics, e-content design and management, Big Data processing, content development, processing, and management for independent performance in the field of digital humanities;* *• To provide students with comprehensive knowledge in digital humanities, developing their specific competences and skills necessary to work in the multidisciplinary environment;* *• To develop students' logical and cognitive skills, enhance their creative abilities, engaging them in the life-long learning and promoting their development as a full-fledged personality capable to act independently, successfully assess professional risks, and make efficient decisions;* *• To develop students' critical, strategic, divergent and convergent thinking and analytical skills;* *• To develop competences and skills in digital cultural heritage preservation and management, e-model management and design, language technologies, coding in humanities/cultural contexts and maps, application design;* *• To develop students' oral and written communication skills in the multicultural environment, promoting the development of students' accuracy of expression in the English for special purposes in the field of digital humanities;* *• To implement the study process adopting student-centered approach to education, to timely update the resource base, to adapt the curriculum of the program and teaching methods in line with the changing requirements of the labor market, adopting newest developments in the field of digital humanities;* *• To promote cooperation among academic staff and students in conducting scientific research and practical application of research results in accordance with international standards and tendencies in the field of digital humanities, facilitating their international mobility and participation in interdisciplinary projects.*

Results of the study programme	*Upon completion of the academic Master study program "Digital Humanities" graduates are:* *• able to demonstrate advanced knowledge and understanding in the field of digital humanities;* *• able to recognize and compare different digital humanities theories, sociological macro and micro theories, and apply these theories in empirical data analysis;* *• able to use a range of knowledge management technologies: information transmission, storage and processing technologies, to identify and structure elements of e-content and knowledge management;* *• able to work across various disciplines performing a range of multidisciplinary tasks (information mining, information architecture, content management, contextualization, web document creation, teleworking, business applications of social networks, terminotics, internet marketing, culture studies, etc.);* *• able to develop and improve different types of e-models for resolving context-based tasks, including e-commerce, e-project management, e-learning content; employ and manage technologies and applications, as well as evaluate e-model application possibilities and mechanisms for their quality assessment and improvement;* *• able to use methods of natural language processing and heuristically informed search algorithms;* *• able to develop and manage interdisciplinary projects according to the provided guidelines;* *• able to design, improve and assess multimedia models through interdisciplinary prism of humanities, engineering, social, cultural and natural science processes;* *• able to digitalize different types of textual data;* *• able to process audio and video data, conduct research considering data representation, visualization, archiving, and transfer operations;* *• able to use the acquired technical skills in solving interlingual communication related problems in general and professional contexts;* *• able to efficiently apply text formation theory skills and demonstrate basic skills of proofreading and copyediting;* *• able to independently use digital humanities theoretical concepts, methods and problem-solving skills to conduct research in the field of IT, e-learning content development, language technologies, gameficiation, edutainment, interdisciplinary andragogy, cognitive linguistics, etc.;* *• able to conduct scientific research and compile research reports within the framework of the chosen module;* *• able to independently make decisions within own scope of responsibilities;* *• able to evaluate the relevance of one's own professional competences and skills to the occupational standard and the requirements of the international labor market;* *• able to work according to the principles of professional ethics.*

Final examination upon the completion of the study programme	*Upon completion of the Master study program, students shall pass a state examination, which is assessed according to a 10-grade scale. Viva Voce of the Master Thesis makes part of the state examination. The Master Thesis amounting to 20 credit points consists of the theoretical and empirical/analytical parts (project). In the theoretical part of the Master Thesis, students investigate a selected issue in the field of digital humanities and provide an overview of the relevant theoretical literature, substantiate the topicality of the chosen theme and analyze its impact on the development of the field. The empirical/analytical (project) part of the Master Thesis presents a case study on 1) the challenges of meaning representation exploiting, tailoring, approbating and developing a technology, web applications or model; 2) the challenges associated with preservation, management and digitization of cultural heritage; 3) the development, analysis, practical application and approbation of a technology, web application, mobile app or various models, e.g., a description of a developed e-learning course, applied software, web page development project, etc.; 4) the challenges in representation, processing and transfer of multimodal and intersemiotic information; 5) storage and archiving of multimedia information; 6) graphical analysis and visualization of data; 7) introduction and incorporation of edutainment principles into modern educational models and social activities, etc. The process of development, the content, range of themes, volume, supervision, reviewing and viva voce procedures of the Master Thesis are regulated by internal RTU regulatory documents, FETH "Academic Research Student Handbook", "Formatting and Style Guidelines for Study and Graduate Papers " and "Regulation on the Development of the Graduate Papers". The student submits an application for the topic of the Master Thesis, which is approved by the supervisor, the head of the study program and finally by FETH Dean who issues an appropriate order. Students develop their Master Theses independently in accordance with the study plan during the last semester of their studies consulting both the supervisor and, if necessary, a specialist in the respective field.*

Study programme forms

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor degree in natural sciences or engineering science, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education; or Bachelor degree in humanities, arts, education sciences or social sciences, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education and English language proficiency equivalent to at least CEFR B2 level*

Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Digital Humanities*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The Master study program "Digital Humanities" is implemented by RTU Faculty of E-learning Technologies and Humanities in the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science". In the previous accreditation period, the code assigned to the study program was 45482, and according to the decision of the Accreditation Committee, graduates are awarded an Engineering Master Degree in Digital Humanities. The duration of the study program is 2 years; volume to be acquired by all applicants – 80 CP/ 120 ECTS.

The study program was reviewed and approved at the meetings of both FETH Council and the Study Field Committee "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science" of 10 February 2017, Minutes No. 12000-8/3. The study program was approved at the meeting of RTU Senate on 20 February 2017 (Minutes No. 607) (see Annex). The description of the study program and the list of study courses are given in Annex P10. Numerous changes to the study program parameters were approved at the meetings of the Study Field Committee on 27 April 2022 (Minutes No 12000-8/4) and at the meeting of FETH Council on 29 April 2022 (Minutes No 94):

- It was resolved that the language of instruction of the study program would be only English. This provides opportunities for exchange of good practice as foreign students study at the study program together with the local students, this also allows attracting prominent foreign lecturers, secures access to the latest learning aids and research materials, provides wider employment opportunities for the students upon graduation, since the knowledge of professional terminology and special language is developed in the course of studies.
- New admission requirements were approved. The students with (1) a Bachelor degree in natural sciences or engineering sciences, or a professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education; or (2) a Bachelor degree in humanities, arts, education sciences or social sciences, or a professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education may be enrolled in the study program.
- The new education classification code of the study program was approved. Due to the changes in the classification codes of the study programs in Latvia (Cabinet Regulations No. 322), it was necessary to specify the study program code in accordance with the thematic field, strategic vision, and taking into account global trends in the relevant field of science. The code of the study program is 45526 – other engineering sciences with the degree to be awarded "Master of Engineering in Digital Humanities". The selected code most accurately reflects the nature and content of the study program. The study program comprises study courses that provide multifaceted knowledge on the current issues in IT, comprehensively develop student skills and competencies corresponding to the profile of the Master degree in engineering, promote fast and efficient solution to contextual interdisciplinary tasks, help

improve, develop, and research the tools, approaches, and technologies to improve the quality of human life. The interdisciplinary nature of the curriculum and structure of the study program, which has been developed in view of RTU rich traditions in the field of engineering education, has helped attract applicant attention and gained recognition both in Latvia and abroad.

Students have particularly appreciated the opportunity to obtain a Master degree in engineering in this emerging field of scientific and academic research, thus improving their competitiveness in the national and international arena, becoming the most sought-after hybrid-competent specialists and change managers in the country.

Study program management in cooperation with the academic staff involved in the implementation of the study program, visiting professors, students, graduates, cooperation partners, and industry representatives has implemented several changes to the curriculum of the study program in the reporting period. They are listed below in chronological order. The changes were introduced to balance the theoretical and practical components of the study program, to incorporate particularly relevant study courses, to bring the titles of the study courses in compliance with their content, to strengthen each sub-major of the study program, and observe the principles of student-centered education, to offer students opportunity to develop relevant competencies by choosing professional specialization study courses from a wide range of compulsory elective courses. The introduced changes are summarized in the table.

Table 1

Summary of introduced changes

Date	Introduced changes
Minutes No. 38 of FETH Council meeting (18.01.2018)	The title of the course RTC702 was changed from Knowledge Society Technology to Introduction to Knowledge Society Technology and the title of the course RTC711 – from Media Technologies to Graphic Design Technologies.
Minutes No. 70 of FETH Council meeting (15.06.2020)	The study program was supplemented with new study courses developed in compliance with the recommendations of the Licensing Committee. Such courses as ETH716 Introduction to Humanities and Social Sciences, RAE711 Introduction to Engineering Sciences were added. It was recommended to include study courses aimed at strengthening and developing theoretical and practical knowledge and skills in programming languages, including DIP122 Programming Languages, DIP719 Natural Language Processing, DIP720 Python Programming Language. According to the Law on Higher Education Institutions, it was necessary to include the course VSL711 Latvian for the Foreign Students in Part A of the study program for foreign students. Some study courses were transferred from Part A to Part B. These changes would allow students within each major to choose the courses of interest in Part B, thus observing the principles of student-centered education. The following Part A courses were added to Part B1: DIP217 Application Software, DIP221 Development of Web-Applications for the Internet, DIP485 Software Metrology and Planning Models, RTC702 Introduction to Knowledge Society Technology, ETH704 Modern Methods of Text Analysis, VTT706 Creative Writing and Stylistics, HVD414 English, VTT701 Cognition: Meaning Representation, VTT701 Interlingual Information Transfer. The courses RTC723 Introduction to Programming, Design of E-learning Materials and Education Technologies, RTC700 Scientific Modeling and ETH703 Terminology and Terminology were transferred from Part A to Part B1.
Minutes No. 78 of FETH Council meeting (23.12.2020)	The course IEU540 Electronic Commerce and E-business (archived) was excluded from the list of field-specific study courses and the course IVZ861 Marketing and Digital Transformation was included in Part B.
Minutes No. 86 of FETH Council meeting (22.09.2021)	Courses ETH718 Linguistic Analysis of Visual Culture, VTT708 Digital Rhetoric and BĢE727 Technologies for Digitization of Culture Heritage Objects were included.
Minutes No. 92 of FETH Council meeting (16.03.2022)	Strengthening the engineering component of the study program as well as its interdisciplinary nature and structure, the following courses were included in Part B: ETH717 Research of Culture, Language and Technology Synergy in Latvia, ETH719 Introduction to Data Corpus Analysis in Humanities, AAP725 Architectural Morphology in Digital Humanities. In turn, such courses as AAP720 Principles of Design Planning and Management and AAP715 Architectural Morphology and Research Methods were excluded from part B of the study program.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The establishment of the interdisciplinary Master study program "Digital Humanities" is in full compliance with the main aim of the study field "Information Technology, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science", i.e. to fulfill the agenda of digital transformation of Latvia and to attain regional technological leadership adopting excellent research, modern interdisciplinary studies based on cross-border cooperation, and effective interdisciplinary cooperation through joint development initiatives as the main driving force. The engineering Master study program "Digital Humanities" is unique for the Baltic States, that is, none of the universities in Latvia, Lithuania, and Estonia implements a study program in digital humanities.

Licensing the study program "Digital Humanities" and evaluating its curriculum and structure, the Licensing Committee of the study program decided that the degree to be awarded upon completion of the study program should be a Master of Engineering Degree in Digital Humanities. The development of the study program is implemented in accordance with the strategy of the Faculty of E-Learning Technologies and Humanities and the vision of RTU, which sets interdisciplinary engineering as its strategic priority. The previous classification code of the study program "Digital Humanities" was 482 (educational program group "Computer Systems, Databases, and Computer Networks" of the thematic field "Computing" of the educational thematic group "Natural Sciences, Mathematics and Information Technology"). However, evaluating the current world trends in the relevant field of science and in the respective industry, the Council of FETH and the Study Field Committee, which consists of the heads of the study programs, industry representatives, leading members of academic staff, and representatives of the student self-government, have agreed that classification code 526 corresponding to the educational program group "Other Engineering Sciences" of the thematic field "Engineering and Technology" is most relevant for the study program "Digital Humanities".

The fact that the study program is implemented in the field of engineering is an important prerequisite that allows implementing interdisciplinary academic and research projects across the fields of engineering and humanities, social sciences, and arts, involving specialists in all these fields. Such synergy promotes mutual integration and transfer of knowledge generated in several fields and thus contributes to the achievement of the sustainability goals of Latvia.

The Master study program "Digital Humanities" is an interdisciplinary student-centered study program aimed at development of a range of engineering competencies. Digital Humanities (DH) is an emerging field that has acquired leading positions in academia, science, and research. An increasing number of the world's leading universities, including MIT, Oxford University, King's College London, and the University of Vienna, either launch study programs in DH and/or set digital humanities as their strategic priority. The structure, duration, academic focus, and curricula of the study programs vary, however, currently overall more than 40 universities in the EU and across the world award a Master's degree in digital humanities (in the broadest sense of the term).

The Faculty of E-learning Technologies and Humanities has the necessary experience and expertise for successful development of the study program in DH, which envisages:

- establishing excellent interdisciplinary cooperation between several faculties specializing in engineering, humanities, and social sciences (academic staff from 6 faculties participate in the implementation of the study program);
- integrating theoretical framework, methods, paradigms of ICT in each study course of the program (specialists with a degree in engineering and humanities jointly participate in the implementation of several study courses);

- offering several fields of specialization where the DH skills may be applied (the study program allows choosing among 4 sub-majors: Multimodal Information Processing, E-Model Design, Preservation of Cultural Heritage and Digitization of Artifacts, and Language Technologies and Communication);
- introducing the principles of competence-based education in the interdisciplinary study process (students are provided with ample opportunities to choose between more than 40 professional study courses that help develop the required range of competencies);
- implementing a student-centered approach (the diversity of students' needs and learning styles is respected, several curriculum acquisition modes are offered, freedom of choice is ensured);
- attracting the leading DH specialists (the study program is implemented in English for the local and foreign students together in order to ensure exchange of good practices, effective knowledge transfer and provide students with the opportunity to learn from the leading experts in the field).

The aims and tasks of the study program have been formulated in accordance with the University and FETH strategies and are reflected in the detailed learning outcomes. The development path adopted by the program is in line with the National Digital Transformation Guidelines and Education Development Guidelines for 2021-2027 "Skills for the Society of the Future".

The Master study program "Digital Humanities" develops such skills as creative problem solving, implementation and approbation of the customized interdisciplinary solutions, analytical and critical thinking, cognitive flexibility and conceptual thinking, curiosity, and excellent communication skills. These skills help students "get outside the silo" of just one field and successfully apply the methods and paradigms of engineering, humanities, social sciences, and other research fields to solve current interdisciplinary tasks quickly and efficiently.

The concept of the study program differs from the concepts of similar programs either in engineering or humanities, since it envisions that students will simultaneously acquire in-depth knowledge in a range of disciplines, thus becoming not only hybrid-competent specialists with a strategic cross-disciplinary vision but also change managers capable of creating work environment conductive for change and innovation.

Students acquire skills to work with the growing amount of interdisciplinary information and develop their knowledge in the respective field of specialization. The studies last for two full years, during which students undertake compulsory, field-specific, and elective study courses. The volume of the study program (80 CP) and the total duration of studies (2 years) are the same for the students with different previous education:

1) Students with a Bachelor degree in in natural sciences or engineering sciences, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education;

2) Students with a Bachelor degree in humanities, arts, education sciences or social sciences, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education.

In the first semester, students are offered adjustment study courses, within which they acquire the competencies they lack in either information technology or humanities. Students with a Bachelor degree in humanities, arts, education sciences or social sciences, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education are provided the opportunity to acquire knowledge in engineering sciences, to develop skills in programming, web application development for the Internet, to acquire knowledge about application software, knowledge society technologies, software metrology and planning models. Students with a Bachelor degree in in natural sciences or engineering sciences, or professional Bachelor degree in the professional activity areas related to these fields of science, or compatible education are offered to acquire the study courses that provide them with the knowledge on humanities and social sciences, improve their natural language processing skills and foreign language competence, introduce the strategies and principles of meaning representation and interlingual meaning transfer, strengthen their creative writing and text analysis skills.

Further on, the fundamental DH competencies are developed, supplementing the program with the range of compulsory elective study courses according to the sub-major. Compulsory study courses provide students with the knowledge in DH and develop the skills necessary for performing professional activities in the chosen field. Students in detail study the research methods employed by DH, research development and implementation stages, programming languages, analyze the role of artificial intelligence in humanities, comprehensively study interdisciplinary semiotics, digital discourse and rhetoric strategies, and Big Data analytics.

Within the study program, students are offered a wide variety of interdisciplinary study courses in IT, arts, innovation entrepreneurship, publishing, architecture, translation studies, e-pedagogy, sociology and humanities.

In case of termination of the study program, students are offered several opportunities to continue their education (see the Annex). Upon completion of the study program, students obtain a Master Degree in Engineering Science in Digital Humanities, which allows them to enter the European and global education and research area in their chosen field, as well as to successfully compete in the labor market.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Nowadays, when rapid development of modern technologies and exponential growth of information and data volume have promoted major changes in research and social processes, the issue of training high-profile professionals has become particularly topical. This issue is considered not only in the context of international and vertical industry integration, but also in the interdisciplinary perspective. A specialist in Digital Humanities (DH) is a multi-competent professional who organizes, administers, implements, and/or supervises comprehensive research and application of interdisciplinary data mining, digitization, representation and archiving, processing, visualization, and analysis strategies and methods to effectively solve cross-disciplinary challenges.

Highly-qualified professionals in DH are needed to meet interdisciplinary challenges, as they are able to conduct innovative interdisciplinary research, suggest new approaches to solving complex issues, and see new and/or wider collaboration opportunities between related and thematically distant sectors, thus promoting development of several research fields.

The expediency of the academic Master study program “Digital Humanities” is evidenced by the growing demand for hybrid-competent specialists with a degree in an interdisciplinary field in the Latvian and international labor market. Graduates of the study program evaluate and implement the theories and methods of DH in order to solve current contextual tasks and challenges successfully and efficiently, which can be solved only by adopting a cross-disciplinary perspective.

DH specialists are in demand at the state and municipal institutions, IT companies, media centers, e-commerce enterprises, publishing houses, museums, archives, libraries, marketing bureaus, higher education institutions, life-long learning projects, private companies, representatives of foreign companies in Latvia, as well as elsewhere where advanced engineering, IT, network design skills, knowledge of foreign languages, presentation skills and creative approach to work are required. Within the framework of the study program, students are provided with an opportunity to acquire the above-mentioned competencies at an advanced level.

DH professionals are in high demand and successfully work in such fields as digital curation, data science, digital media, metadata analysis, cross-disciplinary text production, cultural heritage preservation, e-knowledge management, technical editing, terminotics, gaming, language technology, digital andragogy, museology, information architecture, e-modeling, digital marketing, e-learning and many other areas.

Advanced level of the acquired theoretical knowledge and practical skills allows our graduates to work at the universities, where they deliver study courses in DH, thus promoting academic and scientific development of this field, popularizing it in Latvia and abroad. For example, Asnāte Rībena, a program graduate, participates in the delivery of the study course “Computer Analysis of Text and Data Visualization” at the University of Latvia, she is also an editor of illustrative materials in the National Encyclopedia (https://enciklopedija.lv/tapsana/131462-Ilustr%C4%81ciju-m%C4%81ksla).

Already during their study years, graduates of the study program receive job offers not only in Latvia, but also abroad. For example, Linda Avotiņa received a job offer while on ERASMUS internship in Spain. After graduation, she has continued working successfully as a UX designer at Ltd Kinesso, Barcelona.

We are glad when our graduates use their academic achievements to solve real work tasks already during their study years. For example, DH skills have proved useful in processing data at the Ministry of Foreign Affairs, preserving artefacts and developing the stock of the Museum of the History of Riga and Navigation, developing strategic partnerships with the State Education Development Agency, or applying own knowledge to promote tourism marketing.

Undoubtedly, IT knowledge component in the DH perspective is decisive when choosing an occupation. Several graduates of the study program work as IT or interdisciplinary project managers (e.g., at Magebit, BRIGHT, BLD.AI, etc.), as graphic designers (e.g., at Kalibrīze), technicians (e.g., at TietoEVRY), GIS system specialists (e.g., at Ltd Envirotech).

The media is another industry where demand for DH professionals remains high. Our students work for LETA, Latvian Television, SDI Media, run their own blogs or vlogs, work in public relations and communication (e.g., LEAD). Program graduates also integrate language technology and edutainment components in their work in the fields of translation, andragogy, and pedagogy. Implementing a student-centered education process, we are confident that graduates of our program will not only acquire theoretical knowledge and practical skills, but also develop flexible thinking, strategic vision, initiative and change management skills, as well as other competencies necessary to build a successful career and take on cross-sectoral activity management.

Knowledge in DH opens opportunities to provide solutions to a number of cross-disciplinary issues. Labor market trends indicate that the demand for such specialists will only increase in both the Latvian and international labor market. Several ad portals, such as www.indeed.com, www.linkedin.com, www.code4lib.org, post hundreds of job ads related to digital humanities. For these reasons, high-impact academic Master study program “Digital Humanities” implemented by RTU Faculty of E-learning Technologies and Humanities is not only in line with the labor market trends and requirements, but is also unique and innovative, since no other higher education institution in Latvia offers the same or similar study programs.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Analyzing student statistics, it can be concluded that overall, the number of enrolled students in the study program is very stable and demonstrates a growing trend despite a moderate decrease in the number of enrolled students in 2021, which can be explained by the continuing pandemic.

In academic year 2018/2019, when the study program was launched, 23 students were admitted, 18 were enrolled in the state budget funded seats. In 2019/2020, the number of enrolled students was already 27, including 17 budget-funded students. In 2020/2021, 44 students were admitted, including 26 budget-funded students. In 2021/2022, 41 students were enrolled, including 25 budget-funded students. Academic year 2021/2022 is a period of choice of various study forms for the Master study program "Digital Humanities" – classes are mostly conducted in a remote face-to-face format with the possibility of receiving on-site consultations observing epidemiological safety rules.

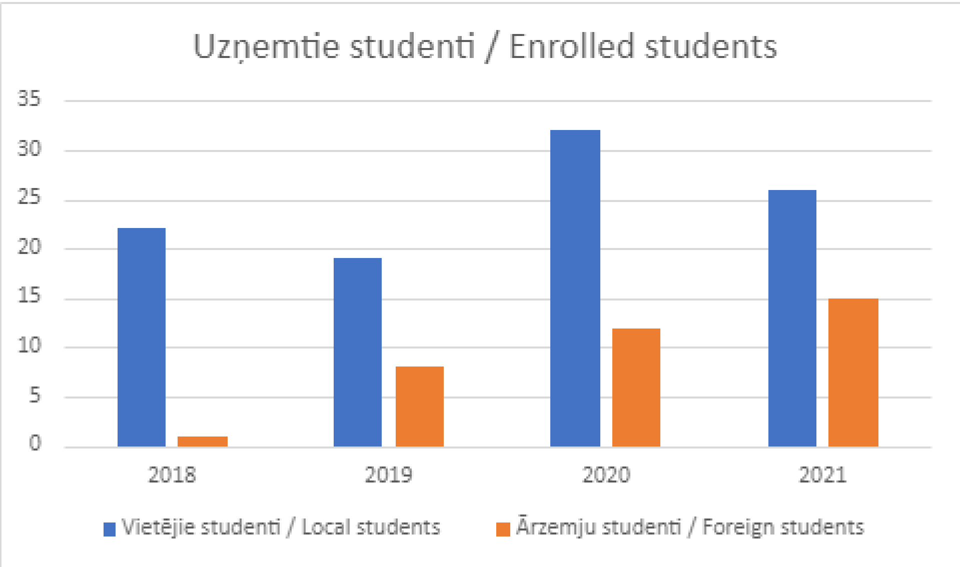


Fig. 1. Enrollment statistics

The number of foreign students is growing rapidly, which can be explained not only by the fact that the study program is implemented in English, its unique character and existing demand for hybrid-competent specialists in the labor market, but also by the distance learning opportunities offered in the conditions of pandemic. It should be noted that the majority of foreign students stay in Latvia during their studies and, if necessary, can attend on-site lectures, tutorials, and seminars, as well as access custom equipped study laboratories. In the first year of the program, one foreign student (from China) was enrolled, in the second year, 8 students from such countries as India, Pakistan, Uzbekistan and China were admitted. In the third enrollment year, the number of foreign students was already 12 and the range of countries included Egypt, Sri Lanka, Uzbekistan, Turkey, Iran, China, and Azerbaijan. In the fourth year of admission, 15 students from Indonesia, India, Iran, Peru, Brazil, Uzbekistan, Turkey, and Russia entered the program. It can be seen that the geography of the countries where foreign students come from has expanded considerably. Currently, a total of 18 foreign students are studying at the study program. One student is on academic leave and/or has obtained extension for the development of the Master Thesis.

Graduate number dynamics is related to the number of students and changes therein. During the reporting period, fluctuations in the number of graduates have been observed. In academic year 2019/2020, the first 10 students completed the study program, including one foreign student. In 2020/2021, 7 students graduated from the study program and in the winter of 2022 another foreign student graduated from the study program. It should be noted that the number of academic leaves granted has increased during this period, as students have been forced to change jobs to adapt to the new study, work and/or family circumstances due to the continuing pandemic.

The main reason for drop-out is that students do not commence studies for which they enrolled. The second most common reason for drop-out at the beginning of studies is that students are not able to combine work with studies. This figure has changed significantly under the influence of COVID19. In few cases, students interrupt their studies because they feel that they have an insufficient level of prior knowledge or that the study program is too complex in terms of content or structure. The number of students expelled at the later stages of studies (2nd and 3rd semesters) is small. These students were exmatriculated for academic failure, which was largely due to their inability to combine work with studies.

Most students, feeling that they are not able to combine work with studies due to health conditions or family circumstances or difficulties in developing a Master Thesis, opt to take academic leave. There are cases when students do not resume their studies after an academic leave.

The administration of the study program maintains close contact with all students and follows their academic calendar as much as possible. Towards the end of the academic leave, students are sent letters inviting them to resume their studies. These letters also contain information about the current schedule and a summary of student's academic arrears. Similar letters are sent to the students who were expelled at a later stage, inviting them to resume their studies, sending them the information about their current academic and/or financial commitments. Promoting the development of the study program and ensuring future growth of the academic and research field of Digital Humanities, the administration of the study program in cooperation with the International Cooperation and Foreign Students Department motivates expelled students to return to the university and continue their studies. Each exmatriculation case is assessed individually.

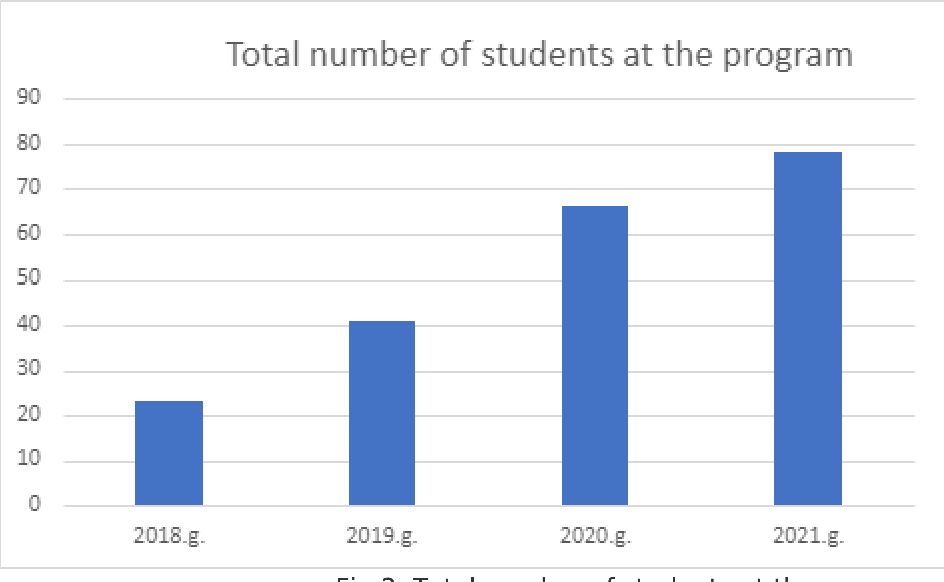


Fig.2. Total number of students at the program

The data given in Annex P05 are taken as of September 15 of each academic year. The total number of first- and second-year students also includes the students on academic leave.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Updating and improvement of the curriculum of the interdisciplinary study program are implemented at several levels, involving students, graduates, instructors responsible for the study courses, the actual lecturers delivering them, and administration of the study program.

The unique interdisciplinary student-centered nature of the study program is reflected in its structure and curriculum. The study program lasts for 4 semesters, the volume of the program is 80 credit points or 120 ECTS. Depending on the previous education, in the first semester students have to take adjustment study courses amounting to 18 CP that develop their knowledge and skills and prepare them for interdisciplinary studies. In the 2nd and 3rd semesters, students acquire both study courses common for all students and the courses in the chosen major. In the 4th semester, students prepare for *viva voce* of their Master Thesis. The table provides information on the structure of the study program.

Table 2

Duration and Volume of the Study Program in Credit Points

	Parts of the study program	Variant 1 80 CP	Variant 2 80 CP
A.	Compulsory study courses, including	36 CP*,**	36 CP*,**
A.	Compulsory study courses common for all students	18 CP	18 CP
A.1.	Compulsory study courses for students holding BA in humanities, arts, social and education sciences (according to program admission requirements)	18 CP	-
A.2.	Compulsory study courses for students holding BEng or BSc (according to program admission requirements)	-	18 CP
B.	Compulsory elective study courses, including field-specific study courses	16 CP	16 CP
C.	Free elective study courses	4 CP/3 CP***	4 CP/3 CP***
D.	Internship	4 CP	4 CP
E.	Final examination	20 CP	20 CP
*	Foreign students should additionally take Latvian in the amount of 1 CP		
**	The students who have not completed study courses in civil defense and environmental protection in the previous study cycle must acquire: Civil Defense amounting to 1 CP Environment and Climate Roadmap amounting to 1 CP		
***	Foreign students shall take elective study courses in the amount of 3 CP, since the course in Latvian (1 CP) in Part A is compulsory for them.		

The proportion of the study courses in the study program structure is represented in the chart below.

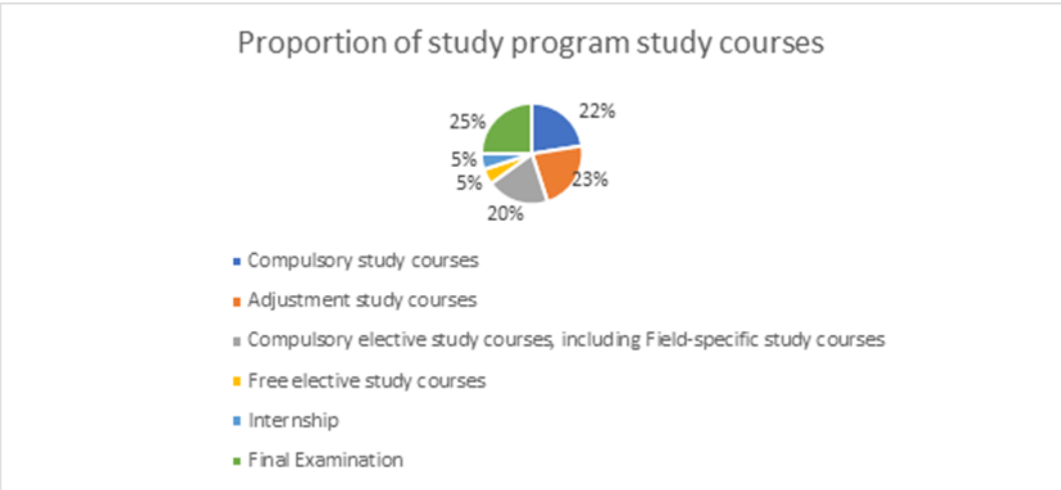


Fig. 3. Proportion of study program study courses

It should be stressed that more than 3/4 of the study courses within the study program have been designed and are taught in an interdisciplinary perspective.

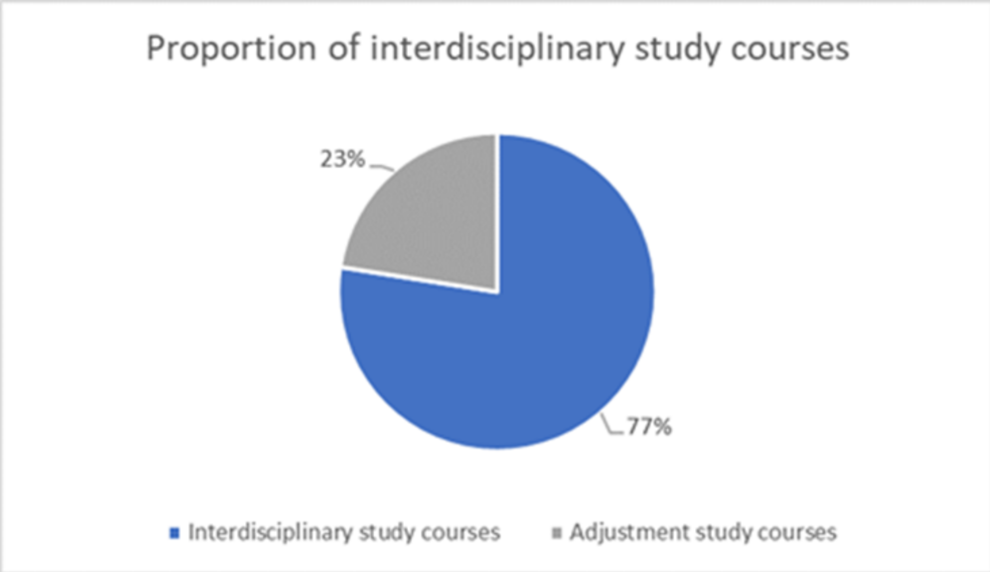


Fig. 4. Proportion of interdisciplinary study courses

Students can choose one out of four study modules: Multimodal Information Processing, E-Model Development, Cultural Heritage Preservation and Digitization of Artifacts, and Language Technology and Communication. Thus, the study program provides students with a unique opportunity not only to develop knowledge in their major, but also to acquire pertinent skills necessary for effective operation in the chosen area. Current academic and scientific trends in digital humanities are taken into consideration developing the study program curriculum. A range of field-specific study courses is regularly reviewed and supplemented, thus providing access to the current professional information, ensuring good practice exchange opportunities, cooperation with specialists in various fields, involvement of industry representatives, and establishes a framework for accumulation and application of theoretical knowledge and practical skills. Changes to the curriculum of the study program were discussed in Section 3.1.1. Curricula of the study courses / modules are regularly updated taking into account the changes in the labor market requirements in the interdisciplinary sector of digital humanities, as well as the included and related sub-sectors thereof, and in line with the latest scientific findings. Efficient sustainable results are achieved in close cooperation with: 1) higher education institutions that take the leading positions in the field of digital humanities, whose academic staff participate both in the delivery of the study courses and updating of the study curriculum (a full list of guest seminars and guest lectures is given in the annex); 2) industry representatives who demonstrate their interest in developing interdisciplinary projects and are eagerly involved in teaching at the study program, providing internship places for the students, and participating in the updating the study curriculum (for example, Tilde, LNB, etc.).

The study courses of the study program promote achievement of the learning outcomes of the program. Each part of study courses, including final examination, promotes development of various skills and achievement of learning outcomes. Compulsory study courses develop students' ability to work at the interface of different fields, performing interdisciplinary tasks (information mining, information architecture, content management, contextualization, network document design, teleworking, social networking for business, terminology, internet marketing, cultural research, etc.). Compulsory and specialization elective courses greatly contribute to the achievement of learning outcomes 1–12 listed in the Mapping of Learning Outcomes of the Study Program.

The study courses promoting the development of the knowledge of interdisciplinary research methods and tools, implementation and management of interdisciplinary projects correlate with learning outcomes 13-14 listed in the Mapping, they provide students with the opportunity to continue their studies at the PhD programs and equip them for future career in science. However, to ensure that graduates of the study program become efficient and responsible individuals supporting diversity, sustainability and social responsibility making use of the advantage offered by STEAM, they should undertake the courses in languages, communication, humanities, and social sciences, which contribute to achievement of learning outcomes 15-17.

A detailed analysis of the correlation between the study courses and learning outcomes of the study program is provided in the Mapping of Learning Outcomes of the Study Program (see Annex P08).

The framework offered by the study program is largely rooted in the theories and practices of andragogy. Students are provided with ample opportunities not only to acquire new knowledge, but also to become change agents and transform their personality. Acquiring new knowledge, students evaluate and formulate, as well as reformulate their own and their classmates' judgments, findings, and experience. This mode of study not only deepens the knowledge acquired previously and creates the new one, but also promotes cognitive flexibility of the students and develops their ability to overcome challenges.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

Currently, the demand for interdisciplinary student-centered education is constantly growing. MSc degree in digital humanities awarded to the graduates of the study program is in high demand in the labor market; it provides wider opportunities to integrate into the modern academic and research environment. These considerations have largely determined the need for the launch of the study program and have affected its structure, content, potential specialization areas and other parameters.

There are four specialization areas within the program – Multimodal Information Processing, E-Model Development, Cultural Heritage Preservation and Digitization of Artifacts, and Language Technology and Communication. All areas of specialization share a common knowledge framework in digital humanities. However, following the principles of student-centered education, students of the study program are offered more than 40 courses of professional specialization that have been designed and / or adapted to the aims and tasks of digital humanities and acquisition of which will help students integrate into contemporary academic, research and work environment. Digital humanities follow diverse development paths. Figure below illustrates the general composition of the area of digital humanities.

Fig. 5. Keywords in digital humanities, following Schreibman, Siemens and Unsworth, https://www.tdbowman.com/2012/09/scientometrics-scholarly-communication-and-big-data-oh-my/

All changes made to the structure of the study program and amendments to its curriculum are fully in line with the development trends in the field. The word cloud representing key words of the study program is provided below.

Fig. 6. Keywords of the study program.

This mode of knowledge transfer is possible provided that highly qualified academic staff, who regularly publish their research results in scientific journals and present reports at the local and international conferences, forums, congresses, are involved in the implementation of the study program. Wide geographic representation of conference reports of the faculty, thematic diversity of their publications, and interdisciplinarity of research projects clearly attest that awarding of an engineering degree in digital humanities is comprehensively based on the achievements and knowledge of the respective research field. Full description of the qualification of the academic staff is provided in Section 3.4 of this report and the related annexes.

The broad semantics of the concept of digital humanities allows addressing many interdisciplinary issues that would not be comprehensively developed or even go unnoticed in a monodisciplinary perspective. Flexible theoretical framework of the study field provides opportunity to apply research methods of engineering sciences, social and cultural sciences, and humanities.

Graduates of the study program are specialists with an in-depth knowledge in IT, natural language processing, digital rhetoric, digital discourse, interdisciplinary semiotics, digitization of cultural objects, corpus data analysis, programming languages and other fields. The acquired knowledge allows them to freely integrate into the academic and research environment choosing a pedagogical career and/or participating in research projects that have a high added value and significantly contribute to the national economic development. For example, Lora Egle, a 2nd year student of the program, is actively involved in the digitization of the archives of the Latvian diaspora. Her Master Thesis has been developed within a project dedicated to the preservation of Latvian culture. The student has already published articles on the chosen issue, including ones published abroad, e.g., her article “The Legacy of the Munster Latvian Gymnasium in Latvian Politics” was published in the book “2021 – Thirty Years Since the Renewal of Latvia’s and Germany’s Diplomatic Relations”, available at: https://www.kas.de/documents/262055/15526575/2021+Thirty+Years+Since+the+Renewal+Book.pdf/d2525ed8-cca3-70fa-6480-b875c18a0028?t=1637676333180 . The author has received positive feedback on the content and quality of the article.

The acquired knowledge was also successfully used in the digital analysis of poetic texts. The competence of the student of the study program Mairita Lukianska helped create added value for the exposition "From Alexander to Chuck". The initiative she proposed – to carry out digital analysis of poetic texts – turned out to be immense success and yielded interesting results. The event can be accessed following the link: https://klasika.lsm.lv/lv/raksts/vakara-autorprogramma/no-aleksandra-lidz-cakam.-ii.-migla-asaro-logs.a150636/.

It is important to note that foreign students with considerable research and work experience have decided to enroll in the study program. A first-year student Hatice Irmakli has already published 3 research papers, including “Cyber Bullying: Global and Local Practices on Awareness Raising”, IGI Global Pembecıoglu, E. N., & Irmaklı, H. (2019). Cyber Bullying: Global and Local Practices on Awareness Raising. In M. Yildiz, M. Fazal, M. Ahn, R. Feirsen, & S. Ozdemir (Eds.), ***Handbook of Research on Media Literacy Research and Applications Across Disciplines*** (pp. 379-401). Hershey, PA: IGI Global. DOI:10.4018/978-1-5225-9261-7.ch022 07/2019. She has participated in many conferences and projects.

The word cloud presented below allows describing the diversity of research topics submitted by the students and highlighting their relevance for the research areas studied by the academic staff of the study program, thus reaffirming that awarding of an engineering degree in digital humanities is based on the achievements and knowledge in the respective field.

Fig. 7. Keywords describing Master student research

The range of research topics for the Master students is supplemented every year, and along with the development of digital humanities, new research areas will be established in future.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Observing the external and internal regulatory documents governing higher education, as well as the fundamental principles of student-centered learning (inspired by Student-Centered Learnnig Toolkit https://www.esu-online.org/wp-content/uploads/2016/07/100814-SCL.pdf), study program management regularly assesses the methods used in delivery of the study courses and study modules, emphasizing the role of methodology in achieving the aims and learning outcomes of the study program and individual study courses. The curriculum of the interdisciplinary study program is designed ensuring the balance between the volume of theoretical and practical courses. This approach is also adopted creating the curriculum of individual study courses. Specialists from various fields participate in the implementation of such courses as *Digital discourse*, *Terminology and Terminography*, *Introduction to Data Corpus Analysis in Humanities, Introduction to Digital Humanities, Research of Culture, Language and Technology Synergy in Latvia,* in such a way helping create the required level of interdisciplinary theoretical knowledge and develop practical skills.

The study program is implemented in English, which provides all students with equal opportunities to acquire the curriculum using top-rate study materials, participating in guest lectures, going on mobility trips, looking for opportunities for academic cooperation abroad, sharing experience at the international level.

Following **the principle of ongoing reflexive process,** one of the principles of student-centered learning, as well as considering the feedback from study program graduates, the administration of the study program organizes monthly meetings with students. At the meetings, current academic, research, extracurricular activities, and other issues are discussed. Establishing clear feedback lines helps respond faster and more efficiently to any study process related challenges. During COVID19 pandemic, all meetings were organized in the online format using different platforms.

Epidemiological safety regulations related to COVID19 also influenced class scheduling, providing that the study modes used in study program implementation, such as lectures, practical classes, workshops and colloquia, laboratory works, study module seminars, guest lectures, job visits, were organized in a remote, onsite and hybrid formats, observing the regulations on the minimum number of contact hours.

The studies at a post-graduate level imply that students acquire the curriculum both attending the classes and by means of **self-study**. The obligatory minimum proportion of contact hours is 40% of the total study course volume. **Self-study** implies that students have to independently read a significant amount of literature, however, in order to avoid student overloading, information about considerable time and effort consuming works is summarized and study program management schedules the work during semester.

Implementing the interdisciplinary study program, it is necessary to offer different **problem-solving models for diverse challenges**. Within these models, students' cognitive skills and abilities, critical and analytical thinking skills, as well as their ability to generate content, self-study and participate in the study process are taken into account. This approach envisages offering students different paths to achieving learning outcomes, as 'One-Size-Fits-All' approach is not effective, e.g., within the study course *Artificial Intelligence in Humanities*, students can qualify for the exam using diverse ways of collecting the required number of test points.

Developing study program curriculum, special attention is paid to **different learning styles of the students**, since students have the opportunity to acquire the curriculum using the learning mode most suitable for them. Many study courses are designed to enable students to perceive information *(1) in both visual and audio mode* (recorded lectures of RTU and visiting professors within the course *Interdisciplinary Semiotics*, *Terminology and Terminography*, etc., practical tasks on audio and video information processing within the courses *Audio and Video Data Processing*, *Graphic Design Technologies*, etc.), *(2) sequentially* (solving tasks, filling in forms and reports helps acquire the subject faster and more efficiently, e.g., *Introduction to Data Corpus Analysis in Humanities*, *Introduction to Big Data Analytics, Natural Language Processing*), *(3) globally*, e.g., *Introduction to Digital Humanities*, *Digital Rhetoric*. Within their study courses, academic staff use the most up-to-date pedagogical tools that complement and reinforce traditional teaching methods (Moodle, all Ortus tools, MS Teams, Office 365, Mentimeter, decision-making algorithms).

Diverse student needs and interests are taken into consideration by offering them the widest possible number of specializations (4) and a range of specialization study courses (more than 40), which are regularly updated and reviewed. Students are offered to attend a series of seminars and study modules aimed at promoting their professional growth in the chosen field, taking into consideration its development trends. Study modules are delivered by local and foreign specialists from Tilde Ltd, University of Latvia, King's College London (KCL), University of Tartu, Vrije Universität Brussels, Linnaeus University, Western University, School of Advanced Studies, etc. For example, in academic year 2021/2022, Professor of Digital Humanities at KCL Stuart Dunn delivered a module consisting of 6 lectures and colloquia "Spatial Humanities: Maps, Mapping and the Human Record" with a special focus on the use of GIS systems and geodata analysis in contemporary culture research. The study module was attended not only by students, but also by researchers from RTU and other Latvian HEIs. A full list of guest lectures and guest seminars organized in the reporting period is provided in Annex.

This approach provides students with the **freedom of choice** and grants them opportunities to influence and, to some extent, determine the content of their studies and have control over their learning. Students are motivated to freely formulate ambitious, market-driven, topical, interdisciplinary themes for their Master Thesis if they manage to provide a valid substantiation (see Section 3.2.6).

Taking **control of planning their study time**, students have the opportunity to apply for ERASMU + and other mobility study and internship exchange trips. As a result, they can find a new impetus for the development of their research, find consultants to their Master Theses, and receive job offers. Students are encouraged to engage in a variety of extracurricular activities, information on these activities is consistently posted on ORTUS portal, circulated via e-mails or other means of communication. RTU has developed a procedure for the recognition of non-formal education, awarding credit points for the gained learning outcomes. Students are encouraged to search for information independently in various resources, e.g., www.digitalhumanities.lv.

Considering that students have **different academic and professional experience**, the study program offers students the opportunity to acquire adjustment study courses in the first semester. To advance students' English language competence, they have the opportunity to choose English as an elective study course. In addition, they may attend English language courses of various formats, levels, and intensity free of charge.

Student-centered learning is possible only if **cooperation between students and academic staff** is ensured. Within the study program, it is implemented by organizing semestral surveys (twice a semester), in which students have the opportunity to express their opinion freely and anonymously about the course curriculum, delivery, mode, performance of academic staff and other aspects in line with the principle of reflection. Survey results are carefully analyzed and discussed with both students and faculty. Students express their opinion about the organization of the study process, improvement of the study program, name the study courses they would like to take choosing a particular major. For example, as a result of such discussions, study courses *Linguistic Analysis of Visual Culture*, *Digital Rhetoric* and *Technologies for Digitisation of Culture Heritage Objects* were developed and included in the program.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Within the study program, students have to undergo internship amounting to 4 CP, which is evaluated according to a 10-point grading system. The aim of the internship is to practically reinforce the theoretical knowledge and advance skills acquired by the students in the interdisciplinary field of Digital Humanities. Internship tasks are formulated for each student individually according to the individual work plan. The tasks formulated in the plan correspond to the areas of knowledge to be acquired within the study program. Execution of tasks is monitored by the Internship Supervisor at the company and the Internship Coordinator at the university. Internship tasks are formulated taking into account the current development trends in the chosen interdisciplinary field. The course is acquired independently in regular consultations with the Internship Supervisor and Internship Coordinator and following the guidelines for development of the Internship Report. Consultations on the course of the internship are provided regularly, students weekly have the opportunity to apply for individual consultations and receive answers to their queries. Interim reports may also be submitted (if necessary).

During internship, students should gain understanding of work practices at the institutions or companies whose professional activities are related to one of the specialization areas of the study program. Internship takes place within the semester according to the work schedule coordinated between the student and institution/company. Both local and foreign students have ample opportunities for internship in the local and international companies, agreeing on the format of the internship in each separate case (on-site, remote online format, virtual, hybrid format). Students are invited to choose places of internship where at least one of the working languages is English. The internship procedure is documented in English. The internship reports are drawn up in English and public presentation of the internship report also takes place in English. Students have the opportunity to undertake internship at a Latvian or foreign establishment, e.g., the Latvian State Archives, National Library of Latvia, State Language Center, etc.

In order to acquaint students with internship opportunities, administration of the study program in cooperation with partner universities (e.g., the University of Latvia) and partner institutions (e.g., TILDE, the National Library of Latvia) organizes virtual and/or on-site Internship Days. Students are given the opportunity to ask questions to potential employers while visiting companies, try to complete small tasks in order to gain better understanding of internship organization model.

Given the challenges posed by COVID19, in academic years of 2020/2021 and 2021/2022, students were provided the opportunity to undergo internship in another semester, e.g., in the summer semester. Contacting foreign partners, the possibility of offering students virtual internship in cooperation with Linnaeus University, Sweden, is being currently considered. This opportunity will emerge when Riga Technical University joins the iSchool organization. All documents are currently being drawn up. Membership in the organization will significantly expand the opportunities for students to apply for exchange trips, including practical placement semesters, internship visits, internship hours, etc. Further information on the organization of iSchool, its guidelines, policies, and members is available at https://ischools.org/

The guidelines for organizing student internships, all necessary documents and task performance procedures are described in detail in section “Internship” of “Academic Research Manual” (pp. 21–27). The book is available at https://ebooks.rtu.lv/wp-content/uploads/sites/32/2021/04/9789934226113_Handbook_Digital_Humanities_full.pdf. FETH has updated the Methodological Guidelines for Organization and Assessemnt of Internship, which were approved at the meeting of FETH Council (Minutes No 94).

For the duration of the study program, students have completed internship at the leading digital agencies, state and municipal institutions, media agencies, cultural enterprises and foundations, representative offices of international companies in Latvia, companies engaged in the maintenance of computer hardware, electrical and other equipment; software and mobile application development agencies; education, e-learning and professional development institutions, companies providing business process formalization, optimization and automation services, establishments that offer cyber security services, companies providing graphic design and visual identity services, e-commerce companies, etc. A wide range of companies operate in the fields fully in line with the specifics, goals and learning outcomes of the study fields covered by the study program. Some companies and institutions are listed below.

1. Latvian enterprises, e.g.:

- Ltd LETA (two students)
- Bureau of the Chartered Accountant of Jānis Avotiņš
- Ltd Intea
- Ltd Envirotech
- Ltd IDT Media
- Ltd Simourg
- Ltd Prog
- Ltd FCR Digital
- Ltd BSMS
- Ltd Ibanpay
- Ltd Brauns
- Ltd Mailos
- Ltd INLAB
- Ltd M company
- Ltd EDGE Technologies
- Ltd Bright

2. State and municipal establishments, e.g.:

- National Library of Latvia (two students);
- Latvian State Archives;
- Public Ltd Latvian Television;
- State Education Development Agency;
- Tourism Department of the Investment and Development Agency of Latvia;
- Ministry of Foreign Affairs of the Republic of Latvia;
- Faculty of Social Sciences of the University of Latvia;
- Institute of Literature, Folklore and Art of the University of Latvia (two students);
- RTU International Cooperation and Foreign Students Department;
- Foundation "Riga Technical University Development Fund" (two students);
- Museum of the History of Riga and Navigation (two students);
- Representative office of a foreign organization "World Federation of Free Latvians";
- Riga City Orchestra "Riga".

3. International foundations, e.g.:

- ifP&C Insurance JSC, Latvian branch;
- IREX Fund;
- Printify.

4. Foreign companies, e.g.:

- NAJTECH- NEC (Saudi Arabia);
- Day Translations;
- Guilin Pingshan Primary School (China);
- APL Appliance repair company (USA).

It is important to note that the majority of students (more than 80%) undergo internship at their current job, which vividly justifies the expediency of the study program and allows demonstrating that it is in demand in both local and international labor market.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Upon completion of the Master study program, students have to develop a Master Thesis. The Master Thesis amounting to 20 credit points consists of a theoretical and empirical/analytical part (project). In the theoretical part of the Master Thesis, students analyze the chosen issue in digital humanities and provide an overview of the relevant theoretical literature, substantiate the topicality of the chosen theme, and analyze its impact on the development of the field. Elaboration and viva voce of the Master Thesis are an essential and effective tool for developing student skills in identifying and solving interdisciplinary problems, as well as their academic presentation skills.

The empirical/analytical (project) part of the Master Thesis presents a case study on 1) the challenges of meaning representation exploiting, tailoring, approbating and developing a technology, web applications or model; 2) the challenges associated with preservation, management and digitization of cultural heritage; 3) the development, analysis, practical application and approbation of a technology, web application, mobile app or various models, e.g., a description of a developed e-leaning course, applied software, web page development project, etc.; 4) the challenges in representation, processing and transfer of multimodal and intersemiotic information; 5) storage and archiving of multimedia information; 6) graphical analysis and visualization of data; 7) introduction and incorporation of edutainment principles into modern educational models and social activities, etc.

Students of the Master study program formulate the theme of the graduation paper independently in consultation with the scientific adviser(s). Due to the pronounced interdisciplinary nature of the study program, it is often necessary to appoint two scientific advisers and/or invite consultants to supervise the Master Thesis. Students are motivated to select the themes for the Master Thesis that are directly related to their job responsibilities, challenges in the chosen field to be addressed in an interdisciplinary way, specific contextual tasks, ambitious projects, or ideas. Some themes of the elaborated Master Theses are listed below:

- Analysis and Classification of Methods used in Generative Art
- BERT Integration into Google Search Algorithm: How Text Origin Affects its SEO
- Narrative in the Digital Age: Case Study and Semiotic Analysis of the Video Game Shadow of The Tomb Rider
- Artificial Intelligence Solutions for Automating the Processing of Scanned Photo Negatives: Analysis of Photonegative Post-processing Process in the Most Significant Memory Institutions in Latvia
- Evaluation of E-government Services: Case of Latvia
- Visualising Image Patterns: Five Years of Latvian Tourism Promotional Photography
- Construction of User: Developer Bias on UX in E-learning Production
- GIS Tools for Developing and Visualizing “Baldone Sanatorium” Site Revitalization

Recommendations

- Developing Guidelines for Readers and Creators to Increase Data Visualization Literacy
- Study of Mobile Phone-based Microlearning
- The Establishment of the Collection Database in the Museum of the History of Riga and Navigation
- Pedagogical Communication in Digital Environment during the Situation of Covid-19
- The Use of Natural Language Processing and Machine Learning Methods in Diplomacy
- User Experience Study for the Mobile Application RunReady
- Semiotics of UI and UX Design Elements of Product Customization-Oriented Online Store
- Adult Education in the Digital Age: Opportunities and Challenges in E-Andragogy

Statistics on the grades awarded for the Master Theses elaborated by program graduates are given in the graph. Information on the graduate dynamics is provided in Section 3.1.4.

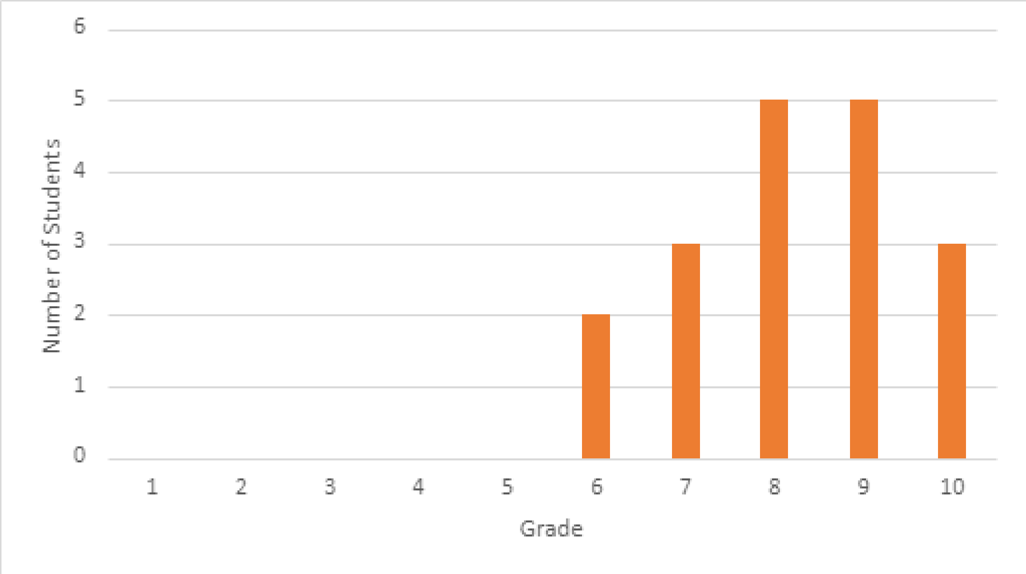


Fig. 8. Master Theses Viva Voce Examination Results

Undoubtedly, elaboration of the Master Thesis in the emerging research field may pose several challenges regarding development of the theoretical framework and analysis of diverse empirical perspectives and good practices. However, we are confident that our students successfully solve this task. The multifaceted nature of the themes of Master Theses opens wider opportunities for cooperation – academic staff from five RTU faculties (FETH, Faculty of Computer Science and Information Technology, Faculty of Electronics and Telecommunications, Faculty of Architecture, Faculty of Engineering Economics and Management) are involved in supervising, consulting and reviewing the Theses, experts from other Latvian (University of Latvia) and foreign universities (Linnaeus University, Sweden) are invited, world-class specialists from leading foreign universities (King’s College London) also participate in graduate paper elaboration process. Consultants are often invited to help in the development of the Master Theses, including representatives of perspective employers and related companies, and other specialists. It evidences the topicality of research conducted within the Master Theses in solving real industry tasks and attests to the broad strategic interdisciplinary vision of specialists in digital humanities, their ability to take on change management and their focus on achieving results.

Elaboration and viva voce procedures of the Master Theses are regulated by both RTU internal regulatory enactments, including the Regulation “On Final Examinations at Riga Technical University” (approved by the Senate on 26 April, 2021), as well as custom-designed FETH manuals. Information on Master Thesis elaboration is summarized in the “Academic Research Student Handbook”, which is freely available to all students at https://ebooks.rtu.lv/wp-content/uploads/sites/32/2021/08/9789934226113_Handbook_Digital_Humanities_fullV2-1.pdf . In turn, the formatting and style guidelines for graduation papers are laid down in the "Formatting and Style Guidelines for Study and Graduate Papers" (http://alephfiles.rtu.lv/TUA01/000059675_e.pdf).

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study program "Digital Humanities" is implemented in the modern learning and research environment. Interdisciplinary studies are implemented in various RTU premises in Riga: 1 Kronvalda Boulevard and Ķīpsala Campus. Scheduling the lectures, study program management try to account for student interests and convenience, minimizing the need to frequently change the location of studies, thus providing for sufficient resting time between the classes.

The FETH building on 1 Kronvalda Blvd is equipped with all equipment and facilities necessary for provision of comprehensive higher education in line with modern requirements. Each study premise is equipped with a multimedia unit – a computer with an Internet connection, speakers, and a projector, which is regularly updated. Even though in the conditions of the pandemic, the study process was mostly organized in the online format, the faculty had access to all auditoriums, where the software necessary for delivery and visualization of the lecture materials presenting sample solutions to the definite case studies was installed.

The following study premises are located in the faculty building on 1 Kronvalda Blvd:

- 1 auditorium (120 seats, equipped with multimedia equipment and simultaneous translation equipment);
- 2 auditoriums (40 seats, equipped with multimedia equipment);
- 3 computer rooms (45 places, equipped with multimedia equipment, and upon request of the academic staff, supplemented with software necessary for the study courses).

Auditorium equipment, office and computer equipment, and software for the needs of the study process are continuously improved. Currently at the faculty, there are three computer rooms with 45 (17 + 17 + 11) equipped computer workstations. Students are provided with the software necessary for mastering the program. Software purchase needs are considered annually both within the study field and within each study program.

The resource facilities, which are necessary for delivering the study courses in cooperation with the staff from other faculties are planned in advance and provided in full either at the FETH or other RTU buildings. Apart from the dedicated software used within specific study courses, instructors use the functionalities offered by Ortus e-learning platform and distance learning platforms (MSTeams and Zoom), use MS Office Word, Matlab, etc., as well as various electronic resources, digital libraries, data bases: IEEE Xplore Digital Library, ScienceDirect, Scopus, Web of Science, SpringerLink, etc.

Various digital tools are used to deliver the course HSP704 *Cognitive and Social Psychology* – Mentimeter, Quizizz, Slido survey platform and book data base ProQuest (Ebrary), for which RTU maintains a subscription. Reference management software (Zenodo, Mendeley, and EndNote) is used within the study course RTC721 *Study Design and Implementation.* Within the course VTT701 *Cognition: Meaning Representation*, students get acquainted with software Obsidian (https://obsidian.md/), which helps conduct research in the digital environment, as well as learn how to work with corpora (e.g., https://www.english-corpora.org used for analyzing metaphors).

For student convenience, computer rooms located in Ķīpsala Campus are used to deliver several study courses, e.g., DSP787 *Introduction to Big Data Analytics* and DAA315 *Graphical Editors and Animation Creation Software*. During the COVID19 pandemic, the issue of software availability outside RTU became relevant since it was necessary to ensure high-quality delivery of the study courses. Taking into account the economic situation and observing the principle of equal access to education, free software is used both within the study course DAA315 and other study courses, including free graphical editors GIMP and Inkscape, animation software Synfig, and software documentation and manuals available on the software developer websites. Google Colabs (online programming solution) is used in online delivery of the study course DSP787.

The FCSIT computer class is used to deliver the study course DAA351 *Fundamentals of 3D Graphics Modeling and Animation*. The free 3D graphic editor Blender is used within the study course. Free access tools UNGIN, Orange, Protégé-Frame are mainly used within the study course DSP774. The computer class of the Department of Software Engineering is used for delivery of the study course DIP719 *Natural Language Processing*. Free access software, such as Python, Anaconda, Jupyter, as well as open access books are used within the course. The available equipment, e.g., sensor signal processing and analysis equipment (HW Group): Poseidon 2, STE2, WLD2 is used in delivery of the study course RAE711 *Introduction to Engineering Sciences*. The most modern engineering study center in the Baltic region established by RTU is also used in ensuring the study process – Ķīpsala Campus, which houses most RTU faculties, Design Factory, laboratories, and the Scientific Library.

The Scientific Library of RTU (SL), which provides access to more than 20 databases, is the major resource that ensures the necessary information to the students and faculty alike in their academic and research activities. The detailed information about the Scientific Library is provided in the Self-Assessment Report of the Study Field.

Different resources in digital humanities are currently available in the literature collection compiled specifically for needs of the students and faculty (see Annex). The list of books is regularly reviewed and updated within the scope of available resources.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide

information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The study program is funded from both the state budget and tuition fees paid by local and foreign natural persons. The obtained funds are used for remuneration of the academic staff (including visiting professors) and administrative staff involved in the implementation of the study program, business trips and professional advancement courses for the academic staff, infrastructure development (including the purchase and updating of research and study equipment), purchase of the study literature, scientific books and journals, and to cover other relevant expenses.

Operational information on the use of financial resources attracted to the study program, income and expense flow, funding to be allocated for implementation of the study program and study courses attached thereto in future periods, as well as calculated funding data (including thematic field coefficients for each study course, study field coefficient of the study program, the number of students for whom the funding was calculated and other relevant information) is available to the head of each organizational unit remotely on ORTUS platform.

Study program implementation cost is a variable number. The costs of RTU FETH for implementation of the academic Master study program are calculated per student in accordance with the Cabinet regulations and the methodology developed by RTU and approved by the Senate.

State budget funded seats at the study program “Digital Humanities” are fully filled every year. Every year, from 3 to 5 applicants participate in the competition for each state budget funded seat. This attests the quality of the study program and confirms that there is a stable demand for the graduates of the interdisciplinary study program and hybrid-competent specialists in the labor market in Latvia and Europe.

In order to motivate students to continuously advance their theoretical knowledge, develop and improve practical skills, as well as to promote achievement of better learning outcomes and research indicators, an annual competition for the budget funded study seats is organized in accordance with RTU internal regulations. Student rotation procedures and their conditions are laid down in RTU and FETH regulations (Annex).

Information on the financial resources of the study program is presented in the table below.

Academic year	State subsidy, EUR	Tuition fees at the program, EUR		Total study program funding, EUR	Expedient costs per student, taking into account the current regulations, EUR
		Local student tuition fees, EUR	Foreign student tuition fees, EUR		
2014/2015	-	-	-	-	-
2015/2016	-	-	-	-	-
2016/2017	-	-	-	-	-

2017/2018	-	-	-	-	-
2018/2019	11,890.45	5,130.00	454.05	17,474.50	6344.52
2019/2020	108,901.54	2800.00	25142.49	136,844.03	6607.56
2020/2021	114,467.49	10,021.79	46,442.50	170,931.78	6694.22

Information on the distribution of funding between cost items is provided in the annex to the self-assessment report “Distribution of Funding Between Cost Items”. In turn, information on the minimum required number of students at the program is given in the appendix to the self-assessment report “On the Minimum Number of Students at the Study Programs”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

Highly qualified academic staff from Latvia, foreign visiting professors and visiting researchers, as well as industry representatives are involved in the implementation of the study program, which promotes achievement of comprehensive learning outcomes of the study program in line with the market needs and development trends of the field of digital humanities. Considering that within the program, students can specialize in four possible specialization areas, on average about 30-40 members of academic staff from 6 RTU faculties and other partner institutions are involved in the implementation of the study program every year.

The qualification of all members of academic staff complies with the requirements of the regulatory enactments, which are set for the Master level study programs. All responsible instructors hold a PhD degree in the respective research field, many academic staff members participating in the delivery, improvement and / or administration of study courses have been granted the status of an LCS expert. Information on the distribution of academic staff by position is given in the figure below.

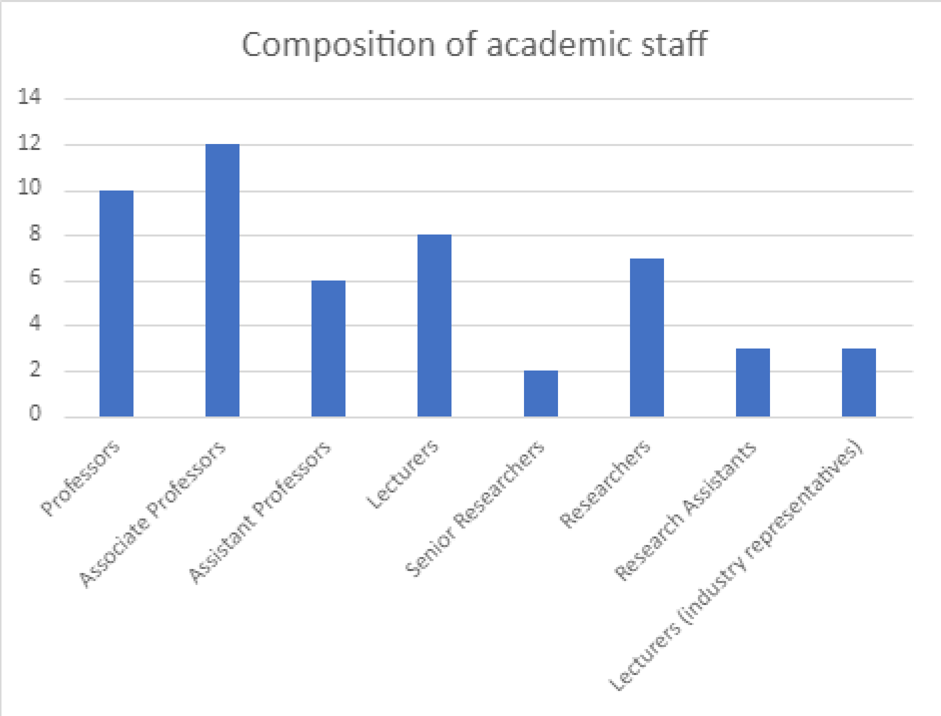


Fig. 9. Composition of academic staff

It is important to note that the contribution of the academic staff working at the study program is highly appreciated at the international level. Our faculty are:

- members of several professional associations, such as the Alliance of Digital Humanities Associations, LTTB, EMT, EST, IABA, Digital Humanities in the Nordic and Baltic Countries, European Association for Digital Humanities, etc.
- have obtained the status of a visiting professor or leading visiting researcher at the universities ranked among the top 50 in the world (e.g., Professor M. Platonova has been granted the status of a visiting fellow in the field of Digital Humanities at King's College London);
- the authors and/or main performers of several scientific projects. In the reporting period, academic personnel managed or participated in more than 30 scientific and academic research projects both in Latvia and abroad;
- invited as plenary speakers. In the reporting period, members of academic staff involved in the implementation of the study program have presented plenary reports in Lithuania, Norway, Russia, Austria, Belgium, Latvia, Italy, and other countries;
- invited to participate in public debates. The faculty participate in radio and television broadcasts at LTV1, LTV4, Radio Baltcom, Brussels DGT Radio, actively publish in the press (Delfi, TVNET, Diena, LSM, Jauns, etc.);
- invited as members of scientific committees of international scientific conferences in Latva, France, Western Europe, Lithuania, Russia and other countries, as well as editorial boards of scientific journals (more than 20);
- invited to review PhD Theses at other universities in Latvia and abroad;
- invited to deliver lectures and participate in other activities across the world.

Detailed information on the qualifications of academic staff, their scientific, academic and expert activities is given in their CVs.

Promoting the international recognition of the study program and ensuring the integration of students in the international labor market and research in digital humanities, the world's leading visiting professors are involved in the implementation of the program, such as Professor Stuart

Dunn from King's College London (the Memorandum of Understanding between RTU FETH and King's College London has been signed), Professor Sanita Reinsone from the Institute of Literature, Folklore and Art (ILFA) of the University of Latvia (the signed cooperation agreement between ILFA and FETH provides for cooperation in internship provision, professional experience exchange and research), Associate Professor Koen Kerremans from Vrije Universität Brussels. It is planned to sign a cooperation agreement with the latter university in the near future. Academic staff from the leading European universities implementing similar programs are invited. For example, Christopher Ohge and Martin Steer developed lecture materials amounting to 4CP for the study course "Introduction to Digital Humanities". Currently, this course is delivered by visiting associate professor Ahmad Kamal from Linnaeus University, Sweden, and PhD candidate Patrick Gawin from the University of Western Ontario, Canada. All visiting faculty carry out research and have published articles in the field of digital humanities, integrating the results of their research into delivery of the respective study courses. The list of lectures and seminars conducted by visiting professors and guest lecturers is given in Annex. In total, during the reporting period, guest lecturers have delivered 22 lectures and/or seminars outside study course curriculum and 138 lectures and/or practical classes within the study courses. Considering that guest lecture planning is a resource and time-consuming process, guest lectures and guest seminars for academic year 2022/2023 are being planned already.

Industry representatives involved in the study process provide students with valuable practical experience-based knowledge and help them develop relevant skills and competences required in the market. For example, Valdis Saulespurens, who apart from being a lecturer is also a business analyst at the National Library of Latvia and for many years has worked as a software developer at Telos/Omnia/Axia and as an instructor at Riga CODING School, not only shares his experience within the study course "Digital Discourse" but in his capacity of a consultant also helps students develop the practical part of their Master Theses. For instance, V. Saulespurens assisted students in developing the codes for *analyzing a song corpus (*Master Theses by Evija Daukste "Analysis of the Correlation between Popular Music and Historical Events from 2010 until 2020"), developing *solutions for image corpus research* (Master Thesis by Asnāte Rībena "Artificial Intelligence Solutions for Automating the Processing of Scanned Photo Negatives: Analysis of Photonegative Post-processing Process in the Most Significant Memory Institutions in Latvia"), providing support in *developing a web page* (Master Thesis by Bao Xiniy "Multimodal Representation of Cultural Heritage in Foreign Language Learning Textbooks") – a resource for foreign students, which helps them get acquainted with the rich cultural heritage of Latvia (see https://storymaps.arcgis.com/stories/c40e9ac5d690497b8380416f55658356).

In 2022, an experienced designer Inga Ropša, who is the manager of the company INGA DESIGN IK (https://www.inga-design.com/index_LV.html) founded in 2012 started working at the study program. The company deals with design and imposition planning, it has been operating in the field of advertising and design for more than ten years.

Andrejs Vasiljevs, the head of Tilde Ltd (https://www.tilde.lv/par-tildi/cilveki), also took part in the implementation of the study course "Terminology and Terminography". He shared his vast practical experience in terminology development, processing and term corpora compilation.

Academic personnel involved in the implementation of the study program constantly improve their qualifications by attending various courses and lifelong learning programs, conducting research, attending conferences and publishing articles in digital humanities or related fields.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

In the reporting period, the composition of the academic staff has changed taking into account the pronounced interdisciplinary nature of the study program. These changes were also influenced by the students' feedback, recommendations and the expressed desire to establish closer cooperation between the faculties, local and foreign universities, as well as to cooperate with the industry. Active engagement of foreign visiting lecturers in delivery of individual lectures, seminars, study courses and modules, as well as closer cooperation with the visiting lecturers from other Latvian universities, was promoted to facilitate development of the field of Digital Humanities in Latvia.

Taking into account the interdisciplinary character of the study program, faculty with the background in both engineering and humanities in the broadest sense of the concept are involved in delivery of the study courses.

In the course of program implementation, study program management have approbated various approaches to delivery of individual study courses, i.e., at some study courses, the lecturers work in tandem at each practical class; at some courses, specialists in the relevant field are invited to present a particular theme; some study courses are delivered by two or more lecturers, each delivering a separate module. Analyzing student and academic staff feedback, as well as the learning outcomes, study program management have concluded that more added value is generated within the interdisciplinary courses that involve two lecturers, one an IT / engineering specialist and the other being a specialist in humanities.

Currently, academic staff from six RTU faculties are involved in the implementation of the study program: Faculty of E-Learning Technologies and Humanities, Faculty of Computer Science and Information Technology, Faculty of Architecture, Faculty of Engineering Economics and Management, Faculty of Electrical and Environmental Engineering, and Faculty of Civil Engineering.

Annually reviewing the range of study courses in Part B of the study program, a tendency has been observed that students increasingly frequently choose the study courses, which are jointly delivered by the lecturers representing several research fields.

In academic year 2018/2019, Dr. Christopher Ohge and Martin Steer from the University of London were invited to deliver the course "Introduction to Digital Humanities". Cooperation with the visiting staff was highly successful and the students appreciated their work. Jane Winters, a leading professor of the School of Advanced Study (SAS) of the University of London and one of Europe's leading researchers in the field of digital humanities, has provided great support for the development of the study program. On her initiative, the program staff had the opportunity to visit SAS, participate in work and research meetings, individual discussions, project presentations and other activities. The structure of the study program and the strategy for promotion of academic research were discussed. The professor plans to deliver some lectures to the students of the study program in May 2022.

In academic year 2019/2020, the study course "Introduction to Digital Humanities" was transferred from the second semester to the third semester due to the pandemic and other circumstances, and starting from 2020/2021, visiting lecturers from Linnaeus University (Sweden) and the University of Western Ontario (Canada) were invited to deliver this course.

Starting with academic year 2020/2021, the study course "Terminology and Terminography" is delivered by two professors: professor Marina Platonova and guest associate professor from Vrije Universität Brussels Koen Kerremans.

In total, the study program is implemented by 10 professors (including one visiting professor); 12 associate professors (including 2 visiting associate professors); 6 assistant professors (including 3 guest assistant professors); 8 lecturers (including two guest lecturers); 7 researchers; 2 leading researchers; 3 research assistants and 3 industry representatives.

Irrespective of the reason for replacement (termination of employment, student complaints, inability to increase the workload or any other organizational issues), the quality of the study course delivery remains high even when new academic staff are attracted. Thus, study program management ensure high quality of the study process, offering students to acquire the necessary knowledge and professional skills in the respective field. The study courses at which the lecturers were changed are listed below:

- Within the study course “English Language”, lecturer Diāna Rūpniece and associate professor Tatjana Hramova replaced lecturer Geoffrey Greenwald. Starting from academic year 2022/2023, it is planned to involve a guest assistant professor from Sumy State University (Ukraine) Alla Krasulia, who has many years of international experience in ESP teaching.
- Within the course “Introduction to Digital Humanities”, Christopher Ohge and Martin Steer were replaced by Ahmad Kamal, a lecturer at Linnaeus University, and Patrick Gavin from the University of Western Ontario. They have expressed willingness to continue running this study course also during the current accreditation period. Students provided positive feedback on their work and the lecturers are satisfied with student performance.
- Within the study course “E-pedagogy and E-didactics”, associate professor Antra Roskoša replaced the leading researcher Jānis Kapenieks. Starting from 2022/2023, this course will be delivered by Alla Krasulia, a guest assistant professor from Sumy State University (Ukraine).
- Within the study course “Graphic Design Technologies”, lecturer Valdis Saulespurēns and industry representative Inga Ropša replaced the researcher Bruno Žuga.
- Within the study course “Study Design and Implementation”, guest professor Sanita Bērziņa-Reinsone replaced associate professor Atis Kapenieks.
- In order to strengthen the research area of interdisciplinary semiotics and culture, visiting associate professor Tatjana Menise joined the academic staff of the program. She delivers the study course “Digital Discourse” together with V. Saulespurens, and the study course “Interdisciplinary Semiotics” together with assoc. prof. T. Smirnova.

Once new study courses were included in the Study Course Register, new lecturers were attracted to deliver them within the study program during the reporting period, for example:

- Professor Māris Kaļinka and researcher Lauris Goldbergs from the Faculty of Civil Engineering deliver the study course “Technologies for Digitisation of Culture Heritage Objects”;
- Professor Alīda Zigmunde (Institute of Humanities, FETH) and assistant professor Ilze Gudro (RTU Research Center for Engineering History) deliver the study course “Research of Culture, Language and Technology Synergy in Latvia”;
- In academic year 2022/2023, a study course “Introduction to Data Corpus Analysis in Humanities” will be delivered by visiting associate professor Tatjana Menise and PhD candidate, researcher from Tartu University Lisa Yankovskaya.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field

of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Since the academic Master study program “Digital Humanities” is highly interdisciplinary, intra-faculty and inter-faculty cooperation is the cornerstone for its successful implementation. Both vertical and horizontal cooperation is maintained and promoted via a range of dedicated activities, cooperation, and promotion of interdisciplinarity are set among the main priorities in curriculum design and quality assurance, as well as strategic development plans of the study program.

Vertical cooperation is ensured by establishing clear lines of communication across all levels of administration at RTU. Academic staff are in direct contact with the head, deputy head and coordinator of the study program on the issues pertaining to curriculum design and testing, and organization and management of the study process. This allows immediately and efficiently addressing the emerging issues. Changes to the program curriculum are implemented in accordance with the strategic development trends of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, approved by the Study Field Committee, the FETH Council, and finally by the Study Department. Vertical cooperation is an essential precondition for making this process efficient and free from bureaucratic hurdles.

Horizontal cooperation is maintained at the intra-faculty and inter-faculty level. Intra-faculty cooperation is promoted through a series of seminars and workshops organized on a regular basis. Members of all FETH units discuss best practices in curriculum design and testing, which allows ensuring uniformity of assessment and avoid overlapping and doubling of study curriculum. Targeted personal cooperation is also promoted. Academic staff implementing the study courses in the same study module get acquainted with the themes students covered in the preceding course and the syllabus of the subsequent study course is adjusted accordingly. The themes that should be addressed in greater detail are covered in view of the level of background knowledge that students were supposed to develop within the preceding course. In such a way, students develop comprehensive understanding of complicated concepts and improve the level of their knowledge from basic to advanced. For example, the syllabi of the study courses AAP723 Cultural Heritage Management and VIA609 Cross-Cultural Aspect of the Language; VTT704 Rhetorical Skills and Strategies and VTT708 Digital Rhetoric; RTC711 Graphic Design Technologies and DAA315 Graphical Editors and Animation Creation Software are coordinated annually to avoid overlapping of the course content, at the same time promoting continuous acquisition of the relevant knowledge and development of relevant competences. Seminars aimed at promoting best practice and experience exchange and informing faculty staff on the quality assurance principles are also regularly organized.

Successful inter-faculty cooperation is essential for implementation of any interdisciplinary study program aimed at educating and training of multi-competent specialists. Some courses within the study program “Digital Humanities” may be implemented only in cooperation with academic staff from different RTU faculties, who jointly deliver the course. For example, instructors in two different areas of knowledge deliver the course ETH713 Digital Discourse Studies - an instructor with the background in humanities teaches the themes on classical discourse analysis, whereas an instructor with the ICT background addresses text processing and modeling tools (sentiment analysis, Python, etc.) and their application in digital discourse studies. The foundation study course ETH700 Introduction to Digital Humanities in different years was delivered by 2 to 4 instructors of various backgrounds to ensure students gain comprehensive understanding of the diverse field of digital humanities. Recently the most efficient cooperation model for delivering the given study course has been promoted with the financial assistance gained within the framework of the research project “Digital Resources for Humanities: Integration and Development” (VPP-IZM-DH-2020/1-0001). The curriculum of the foundation study course has been reconsidered and updated involving DH specialists from Linnaeus University (Sweden) and Western University (Canada), who have willingly agreed to continue delivering this study course in the upcoming accreditation cycle.

Inter-faculty cooperation is also necessary for efficient curriculum design to ensure that new study courses are successfully integrated into the study program. New courses BĢE727 Technologies for Digitization of Culture Heritage Objects, AAP723 Cultural Heritage Management, DIP720 Python Programming Language, and DIP719 Natural Language Processing have been custom designed for the needs of the study program. Curriculum design, planning, and assessment principles were discussed and approved at the meetings of working groups uniting representatives of several faculties and administration of the study program. The principal areas of cooperation maintained at different levels are provided in Table 1 “Areas of Cooperation and Mechanisms of Promotion” (see Appendixes).

The overall structure of the study program, sequencing of the study modules and study courses, composition of the study modules, and integration of new study courses are regularly discussed at the meetings of Curriculum Design and Testing Committee to ensure the study program is streamlined, student-centered and responsive to new requirements posed by the labor market. Active feedback from all stakeholders is welcomed and taken into consideration.

At the time of submission of the self-assessment report (spring semester of academic year 2021/22), there are 48 first year students (both local and foreign students) and 9 members of academic staff delivering respective courses. During the semester, 7-8 study courses were taught depending on the study courses chosen in Part C. Thus, students to faculty ratio is 48 / 9 = 5.33. In the second year, there are 30 students (both local and foreign students) and 11 members of academic staff working with them. During the semester, 1-3 study courses, Master Thesis, Basics of Labor Protection and Civil Defense were taught (if these courses were not taken in the previous study cycle). Thus, students to faculty ratio is 30 / 11 = 2.72.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	HMD0_AkadProgr_Diploms_Pielikums_LV_ENG-combined.pdf	HMD0_AkadProgr_Diploms_Pielikums_LV_ENG-combined.pdf
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_HMD0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	02000-2.1.1-14 (AIP atzinums HMD0 progr.).pdf
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_HMD0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_HMD0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_RHMD0(45526)_AtbilstibaValstsStandartam_AkadMag_EN.pdf	P06_3.2.1_RHMD0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_RHMD0(45526)_Kartejums_lv_Mapping_eng_L.pdf	P08_3.2.1_RHMD0(45526)_Kartejums_lv_Mapping_eng_L.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_RHMD0(45526)_Plans_lv_Plan_eng_Final.pdf	P09_3.2.1_RHMD0(45526)_Plans_lv_Plan_eng_Final.pdf
Descriptions of the study courses/ modules	HMD0 (45526) Study course description EN.zip	HMD0 (45526) Studiju kursu apraksti LV.zip
Description of the organisation of the internship of the students (if applicable)	Internship Guidelines_Digital Humanities.pdf	METODISKĀS VADLĪNIJAS PRAKSES ORGANIZĒŠANAI AKADĒMISKAJĀ MAĢISTRA STUDIJU PROGRAMMĀ "DIGITĀLĀS HUMANITĀRĀS ZINĀTNES".pdf
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Computer Systems (42526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Systems*
Education classification code	*42526*
Type of the study programme	*Professional bachelor study programme*
Name of the study programme director	*Egons*
Surname of the study programme director	*Lavendelis*
E-mail of the study programme director	*Egons.Lavendelis@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089548*
Goal of the study programme	*The aim of the study programme is to prepare high-qualification professionals, i.e., programming engineers (in compliance with the fifth level of qualification of the professional standard of a programming engineer) to perform professional activities in the field of software engineering having a professional knowledge in programming languages, technologies of software development, data structures and algorithms, software development projects management, basic technologies of databases, computer systems architecture and functionality, as well as to participate in a software development project (team), performing different tasks and following IT industry standards and professional ethics. Moreover, to prepare students for the continuation of studies at the professional and academic Master studies level.*

Tasks of the study programme	*Study programme tasks are the following:* *- To provide required knowledge according to the requirements of higher technical engineering education.* *- To provide knowledge in software engineering, computer hardware, database technologies, computer networks, basic methods of artificial intelligence and to introduce students with the best practices of the field.* *- To develop students' ability to use theoretical knowledge in stating and solving certain tasks.* *- To develop students' skills in development of the software, acquisition and use of software environments and software tools.* *- To develop students' ability to independently acquire, evaluate and use new software products.* *- To provide knowledge and practical skills in the design and development of information systems considering development of the corresponding documentation and provision of the mentioned information system's operation.* *- To develop a students' skill in design of information, database, intelligent and software systems.* *- To contribute to students' ability to analyse the gained experience and independently acquire new knowledge.* *- To improve the students' professional skills in foreign languages.* *- To introduce students with the professional ethics and IT industry standards.* *- To improve students' oral and written communication skills as well as to develop students' skills in* *teamwork.* *- To provide experience of the practical work by suggesting students apply the acquired knowledge in practice by solving engineering questions.* *- To give an opportunity to gain qualification "Programming engineer" by developing a Bachelor Thesis where the student performs research and demonstrate ability to relate the acquired theoretical material with the practice.*

Results of the study programme	*Upon completion of the study programme, the graduate: - has acquired knowledge in the field of computer science in general as well as in its formal foundations; - is able to prepare software documentation in accordance with the requirements of the software engineering standards; - is able to understand and analyse software design documentation, requirements specifications, documentation and code of the maintainable system, as well as perform changes in it; - is able to choose the appropriate algorithms, methods, software products and tools for solving problems; - is able to think creatively for developing new methods and approaches to problem solving through computer systems; - is able to develop software according to the best practices of the industry, using good programming style as well as using software development environments and tools; - is able to work independently in his/her professional field; - is able to participate in project development, management, and work in a team, manage, plan and coordinate the working group, considering interests of the society as well as sustainable development; - is able to learn professional literature in a foreign language; - is able to learn new methods and technologies, as well as understands the need for continuous professional development.*
Final examination upon the completion of the study programme	*To receive the professional degree of Bachelor of Engineering in Computer Systems and the qualification of a programming engineer, students must accomplish the syllabus, internship, and develop and defend their Bachelor Thesis with the project part. The Bachelor Thesis contains both research and project parts. The Bachelor Thesis topics are approved by Heads of departments of the Institute of Applied Computer Systems those of where theses are developed. A reviewer is appointed for the Bachelor Thesis evaluation. The requirements to the bachelor thesis with the project part is published online. The State Examination Committee whereof at least 50% must constitute representatives of the employer organizations is formed for the public defence of the Bachelor Thesis. The Commission is headed by the Chair who represents one of the employer organizations.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education or first-level professional higher education in computer systems*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Bachelor Degree in Computer Systems*
Qualification to be obtained (in english)	*Programming Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education or the first level professional higher education in the field of computer systems and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional Bachelor Degree in Computer Systems*
Qualification to be obtained (in english)	*Programming Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

As part of the evaluation procedure of the study field, the educational classification code of the study program was changed to 42526 – other engineering sciences. This change was made in view of the fact that the professional study program “Computer Systems” basically covers computer systems development technologies supplemented by basic engineering courses. Analyzing various sources, including university curricula in the European Union and other countries, it was discovered that today information and communication technologies is a branch of engineering sciences that aims to develop and research methods, tools, approaches, technologies and technical solutions to solve practical problems in order to improve people’s living conditions. This distinguishes information and communication technology as an engineering discipline that uses scientific knowledge to solve practical and technical problems in order to create objects that do not exist in nature, from natural science, which studies the patterns and phenomena that exist in nature. At the same time, programming engineer is a profession of an engineer who participates in creating new computer systems.

In accordance with Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Professional Higher Education of the Second Level”, the volume of the program has been changed from the historically established 161 CP in 2013 to 160 CP in 2022. It is possible to enrol in the study programme after obtaining the general or vocational secondary education, studying for full 8 semesters in this case. The specific of the professional bachelor study program “Computer systems” is that it is possible to enrol in the program also with the previously obtained first-level professional higher education in computer systems. In this case, the credit points obtained from the first-level professional higher education program are recognized in the volume of the bachelor study program in computer systems and the study duration is 3 semesters. To make it possible, additional study courses, supplementing the content of studies to be obtained from the first-level professional higher education (college) programme and corresponding to the standard of the programmer’s profession, are scheduled for 3 semesters that correspond to the 3rd, 6th and 7th semesters from the full program

Given the dynamic nature of IT, the content of the study program and curriculum of each study course are regularly reviewed. At the level of the study program, a regular assessment of the relevance of the existing study course to the current situation in the industry and science is made. If an existing study course is found to be outdated or for any other reason does not fulfil its intended purpose in achieving the objectives of the study program, it is replaced by a new study course. At the level of study course, each responsible instructor reviews the content of their course regularly to ensure that it is up-to-date with the latest technologies and trends in the field. When significant changes are made to a study course, before approving they are discussed at the Council of the Institute of Applied Computer Systems so that all organizational units implementing the study program are aware of the changes and so that consistency between study courses within the program is ensured. In early 2022, a workgroup organized by LIKTA developed a new standard of the programming engineer profession. The content of the program has been significantly redeveloped in conformity with the new standard and Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Professional Higher Education of the Second Level”. General education study courses in engineering such as “Engineering chemistry” and “Electrical engineering and electronics” have been excluded from the program, devoting more attention to the development of specific field-related skills at study courses, which include the professional skills appropriate for a programming engineer and the latest technologies and methods used in the IT field, including artificial intelligence, data storage and software development. The goal of these changes is to improve the compliance of the program content to the occupational standard and thus to the labor market requirements. A full list of changes is provided in Annex P09 – Changes to the Professional Bachelor Study Program “Computer Systems”.

Based on Section 6 of RTU Internal Code of Student Conduct, RTU Code of Academic Integrity and RTU Study Department’s guidelines “Breach of Academic Integrity and Breach Consideration Procedures”, since 2021 an enhanced plagiarism control has been introduced for graduation papers. In 2019, a procedure for reviewing academic integrity violations was adopted (FCSIT Council Decision No. 12000-1.1/9 of 14 June 2019 “On the Procedure for Reviewing Cases of Plagiarism in Graduation Papers of Students at the Faculty of Computer Science and Information Technology of RTU”), ensuring objective review of the violations. Since 2021, electronic plagiarism control has also been introduced for all student papers. An electronic system developed at the Institute of Applied Computer Systems is used for this purpose.

As the program is implemented in full-time on-site mode, in order to ensure that at least 50% of the workload is completed in contact hours, the semester planning has been changed from a 4-week examination period to a single 20-week semester plan for mastering the study course curriculum and examinations in the autumn and spring semesters.

When forwarding the program for accreditation, the program has been supplemented with the second language of its implementation – English. Such selection has been made based on high demand for a similar program – the academic bachelor program “Computer Systems”, as well as wishes expressed by many foreign students to include a full-volume internship in the studies. Implementation of the studies for foreign students is scheduled in a full volume of 8 semesters. It is planned that the study program will be mostly implemented by the academic staff who already have experience in teaching in English at other programs implemented by the Institute of Applied Computer Systems.

The other main parameters of the program – place and type of implementation (full-time intramural) and admission requirements – remained unchanged during the evaluation period.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The full volume of the study program of 160 CP and its duration of 4 years are in compliance with Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the

Professional Higher Education of the Second Level". Such duration and volume of the program allow covering the skills defined in the standard of a Programming Engineer. The skills are acquired at the implemented study courses and during the internship that allow young specialists to start working in the industry already during their studies, which is particularly important given the demand for IT specialists in the Latvian IT sector.

The study program corresponds most closely to the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", as the curriculum of the study program focuses on software engineering and includes knowledge and skills relevant to information technology, computer science and, to some extent, computer engineering and computer control.

The title of the study program "Computer Systems" covers all areas related to software engineering. Computer systems development requires knowledge in computer science, information technology, computer engineering and computer control. The program focuses on computer systems development (systems analysis, systems modeling, design, and algorithmization).

The goal of the study program is to train highly qualified specialists – programming engineers (in compliance with the standards of the 5th qualification level) for professional activity in programming engineering with professional knowledge of programming languages, software development technologies, data structure and algorithms, software development project management, database core technologies, computer system development, and functioning, as well as capable to participate in software development project teams, performing different tasks and observing IT industry standards and professional ethics, as well as to train students for continuing their studies at the professional master study level.

Classification code of the study program "Computer Systems" 42526 – Engineering Sciences and Technologies (other engineering sciences) has been chosen because the aim and curriculum of the program are related to the computer system development, providing engineering solutions to specific problems of social significance and, in its essence, pertaining to engineering sciences. Graduates of the program are awarded the professional Bachelor degree in Computer Systems and the 5th level qualification of a Programming Engineer.

The aim of the study programme is achieved by performing all the study programme's tasks. The tasks of the study program envisage the provision of knowledge, the development of professional and communication skills and abilities necessary to achieve the goal in study courses and internship, as well as conducting independent research within the framework of a bachelor's thesis. The study results are developed according to the tasks and verified in study courses, practice and during the defense of the bachelor's thesis.

It is anticipated to admit secondary education graduates for the first year of the program as a result of a competition. The competition is organized pursuant to the Regulations on Admission to Academic and Professional Basic Study Programs approved by RTU Senate, granting increased value to science study courses from school programs and a foreign language, which forms the basis for successful mastering of the IT field. The admission requirements have not changed in the reporting period and are acknowledged to be qualitative criteria in the selection of students, enabling to achieve the set objectives of the study program and allowing the study program graduates to achieve the set learning outcomes upon successful completion of the studies.

Applicants with the previously obtained first-level professional higher education in computer systems are also enrolled in the program. In such a case, credit points obtained from the first-level professional higher education program are recognized and transferred to the bachelor program in Computer Systems and the study duration is three semesters. In this case, the rank of applicants is formed according to the weighted average grades in the Annex to the Certificate on the First-Level Professional Education.

The duration of the study programme (4 years) is sufficient so that applicants with secondary education can acquire the theoretical and practical knowledge, skills and abilities expected as the results of the study programme to the full extent, as well as obtain the necessary qualifications in accordance with the legislative requirements of Latvia. Applicants with previously obtained first-level professional higher education in the field of computer systems will be able to use the opportunity to count the credit points obtained in the previously studied educational programme into the scope of the Bachelor's programme in Computer Systems, thus reducing the study time from 8 to 3 semesters. The flexibility of this study programme will allow attracting the larger number of potential students and providing the state with the necessary number of specialists in the IT industry.

Since 2013, the following enterprises provided internship opportunities to the students of the program (keeping a company name as it was at that moment): Accenture Latvian Branch, JSC DNB banka, JSC EMERGN, JSC Exigen Services Latvia, JSC Latvenergo, Jēkabpils Municipal Council, Riga Technical University, ScoroSoftwareOÜ, Ltd ABC idea, Ltd AdEvo, Ltd Atea Global Services, Ltd Autentica, Ltd Baltic Tehnology Group, Ltd D8 Corporation, Ltd Datu tehnoloģiju grupa, Ltd DPA, Ltd Equinox Payments Latvia, Ltd First Line Support, Ltd FMS, Ltd Intechsystems, Ltd IT risinājumi.lv, Ltd IT Sapiens, Ltd KASKO Latvia, Ltd Lattelecom Technology, Ltd Meditec, Ltd MIMEKS, Ltd NT Piedzīvojumi, Ltd One-TwoSoftware, Ltd Overly, Ltd Riga Computer, Ltd RIGVIR, Ltd Scandiweb, Ltd sem.lv, Ltd SWH SETS, Ltd Tieto Latvia, Ltd Tilde, Ltd VISMA Enterprise, Valsts meža dienests (State Forest Service), SJSC Latvian Road Maintenance.

The study programme is implemented in two languages – Latvian and English. Before the changes, the language of implementation of the program was only Latvian. The use of the English language in the implementation of the study programme will allow the study programme to increase the number of students thanks to foreign applicants, to participate in international students exchange programs and to improve the indicators of the implementation of the study programme.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 stipulates that ICT advances and their widespread availability are a catalyst for change in the economy, public administration and society as a whole. The knowledge society, through the targeted application of ICT solutions, transforms existing and creates new processes, business models, habits and culture in all spheres of the economy and life. Digital transformation is the key to productivity, economic growth, individual and societal well-being. At the same time, the number of ICT professionals in Latvia, according to the European Commission’s Digital Economy and Society Index, was only 2.2% of the workforce in 2018, well below the European Union (EU) average of 3.7%. The study “Future Goals, Current Directions. Latvia 2022” conducted by the think tank Certus in 2017, revealed that IT sector in Latvia needs up to 3,000 new graduates per year.

According to the Latvian statistics portal, the share of companies employing ICT/IT specialists has increased by 5% in the last 7 years and has reached 73% in 2020. According to the study “Competitiveness of Regions. Latvia Competitiveness Report 2019” conducted by Certus in 2019, the salaries of ICT professionals in leading EU countries are about 30% above the national average, in Latvia the gap is 80%.

Graduates of the study program “Computer Systems” can start a professional career in ICT companies by performing a variety of roles. The study program provides knowledge and skills for junior positions as programmers, testers, system analysts, data analysts and others. According to the Ministry of Education and Science data on 2017 and 2018 graduates, one year after graduation, 100% of graduates are employed in advanced qualification professions according to the Ministry’s classification. The average income one year after graduation is above EUR 25,000 per year and two years after graduation above EUR 22,000 per year. When assessing these figures, it should be noted that the data set was very small. No graduates remain unemployed or emigrate one to two years after graduation. When assessing the employment of graduates by NACE codes, it can be concluded that more than 50% work in the Information and Communication Services sector (J), which corresponds most closely to the profile of the study program. In addition, the second largest number of graduates work in the Agriculture, Forestry and Fishery sector (K), which nowadays intensively develop ICT solutions. In addition, many graduates also work in the IT departments of companies in other sectors. It can therefore be concluded that graduates are mostly working in their major, working in higher qualification professions already one year after graduation, and earning salaries that are well above the national average.

It is very easy for graduates of the study program to get involved in the labour market, which is proven by a large number of available vacancies in Latvia and abroad. In cv.lv (one of the largest job advertisement portals in Latvia), 840 vacancies in the IT field have been published in August of 2022. Positions of different levels in various IT subsectors are offered by Latvian companies and Latvian branches of international companies, such as Accenture (40 vacancies), ATEA (30), EIS group (17). From the offered vacancies, graduates of the study program can apply for various junior specialist vacancies (~180 vacancies), such as junior programmer, junior software developer, junior tester, junior data engineer. There are also a very large number of vacancies available abroad, for example, LinkedIn offers 13,000 junior software developer vacancies in the UK and 12,000 in Germany.

Overall, more than 200 graduates of the study program “Computer Systems” expressed a positive view of the program in all questions in the 2020 survey. On a scale of 5, such aspects as the availability of necessary information during studies (4.11), the availability of literature (4.22), the provision of classroom aids (4.30) and the work of academic staff with the e-learning environment (4.10) were highly rated. Students were also generally satisfied with their choice to study at RTU (3.90), their choice to study in the study program “Computer Systems” (4.30). Students are satisfied with the theoretical (3.50) and practical (3.40) knowledge they have acquired, the schedule of the lectures and the facilities (3.90) in which the lectures were held. It should be noted that since the survey was carried out, the Faculty has moved to new premises, so due to the pandemic, at the time of writing of this report, students have not yet been able to fully experience the learning process in the new location.

The study program Computer Systems is highly rated in prakse.lv surveys. It ranks 2nd among all study programs in Latvia, which shows the high evaluation of entrepreneurs.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The professional bachelor study program “Computer Systems” was implemented only in Latvian in full-time form during the reporting period and after the accreditation its implementation is planned also in English. All students study on the state budget. It is evaluated as a positive factor, as it attests to the study program accessibility for all young people who wish to study engineering sciences.

Over the past four years, a tendency of reduction in the number of students has been observed at the study program, which can be explained by closure of the first- level professional higher education program “Computer Systems”, which resulted in reduction of the number of admitted students, as potential applicants are not trained at the Institute of Applied Computer Systems. During the reporting period, the number of graduates has also decreased, which is related to the total reduction of the number of students and different external circumstances, including the COVID-19 pandemic in the last two years which caused difficulties for students to complete their graduation papers in due time in the remote work and study mode. To increase the number of students at the program, it is planned to open admission for applicants with the secondary education for full 8 study semesters, as well as to implement the program in English, simultaneously retaining the opportunity for local students with the first-level professional education to acquire the program during three semesters.

During the reporting period, the number of exmatriculated students fluctuated from 6 to 16. In most cases, students have been exmatriculated due to academic failure, which happens in the event a student cannot cope with the requirements of the study courses due to different reasons. The largest dropout in the number of students was observed during the last study year, which was mostly caused by academic failure and the inability to complete graduation papers in due time in the conditions of remote studies. 73 students, or 29% of the total number of students have been exmatriculated for academic failure during the reporting period (see Annex P05 – Statistical Data on Students Enrolled in the Professional Bachelor Study Program “Computer Systems”). Students mostly mention a high load that occurs from combining their full-time work and full-time studies as a reason for their failure to fulfill the requirements of the study program. The second most frequent reason why students are expelled is failure to resume studies after an academic leave. There are 2-4 of such students every year. No other pronounced tendencies have been identified, the reasons for extending or terminating studies are different each year. It has to be taken into account that students in the respective major are often employed full-time in the industry and also go for long-lasting business trips. Two students are annually exmatriculated due to other reasons.

Charts with statistical data on the number of students in the study program “Computer Systems” are available in Annex P05 “Statistics on the Students of the Professional Bachelor Study Program “Computer Systems”.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Study program curriculum complies with Cabinet Regulations No 512 of 26 August 2014 “Regulations on the Second Level Professional Higher Education Standard”. The compliance is described in Annex P06 “Compliance of the Professional Bachelor Study Program “Computer Systems” with the State Education Standard”. The study courses included in the study program were developed in compliance with the valid normative acts: Cabinet Regulations No 322 of 13 June 2017 on the Classification of Latvian Education, the Law on Institutions of Higher Education (current version), RTU Study Regulations, Regulations of the Study Course Register and RTU Senate decision on Evaluation of Learning Outcomes of 27 May 2017.

Study course descriptions are regularly updated in line with the needs of the industry, the labor market and trends in the field of computer science and information technology. Considering the rapid changes in the IT industry and technological developments, study courses are regularly updated and study program curriculum is modified, thus ensuring that the study program meets the needs of the labor market and the trends in the IT field. Some examples of changes:

1. The academic staff keep abreast of the use of programming languages and other technologies in the industry, adapting the languages and technologies used to deliver the study courses accordingly. Considering the development of Python, Java and C# languages and their widespread use in the industry, the languages used in several study courses have been changed: “Algorithms and Methods of Programming” is taught using Python, “Algorithmization and Programming of Solutions” – using Java, while the study course “Programming Languages” includes C# and Python languages. Other modern programming languages are also used in other courses as well as in the graduation papers.
2. With the development of new data storage and retrieval technologies, new study courses on database technologies have been developed that incorporate both industry-standard NoSQL approaches and NewSQL concepts.
3. With the development of artificial intelligence approaches, the study course “Introduction to Artificial Intelligence” was replaced with the study course “Selected Topics of Modern Artificial Intelligence”.
4. To better train students to work in a project-oriented environment in the IT industry, the range of group projects in the study courses was extended, requiring students to work in teams to solve software development problems from the first year onwards.
5. Due to the high innovation capacity of the IT industry, the courses on foundations of economics previously included in the program have been replaced by the 6 CP study course “Innovative Product Development and Entrepreneurship” so that students learn not only the theory of entrepreneurship but also the practical processes required to create innovations.
6. In view of the growing global awareness of environmental and climate issues, the study program has introduced the study course “Environment and Climate Roadmap”.

The compulsory part of the study program includes study courses in the amount of 102, which are divided into three subsections. Part A1 of the program includes general education study courses prescribed by Cabinet Regulation No. 512 adopted on 26 August 2014 “Regulation on the State Standard of the Second Level Professional Higher Education” for mastering compulsory parts of the professional bachelor study program – a module of entrepreneurship professional competence, environmental protection, civil defence and occupational safety study courses, as well as general education IT field basic courses. The total volume of part A1 is 12 CP. Part A2 of the program in the volume of 36 CP includes the compulsory field-specific theoretical foundation courses, including higher mathematics, physics, solution algorithmization and programming, analysis of data structure and systems, special sections of artificial intelligence and basics of the sector rights. Part A3 of the program in the volume of 54 CP includes professional specialization study courses appropriate for a programming engineer in the field of algorithmization, programming languages and approach, databases, computer network, computer architecture, software development technology, internet of things, testing and system analysis. Part B1 allows students to select specialized study courses relevant to their interests in the volume of 6 CP, and part B2 (humanities and social study courses) develop students’ basic social, communicative and organizational skills in the volume of 4 CP. Free elective study courses allow students to select the study content appropriate for their professional interests and needs in the volume of 6 CP.

With regard of the fact that the study program has a professional inclination, a minimum of 50% of classes in professional study courses are practical and laboratory works; for some study courses, the volume of practical and laboratory works reaches up to 75%. Examples of such study courses are as follows: “Innovative Product Development and Entrepreneurship”, “Process-Oriented System Development”, “Architecture-Oriented System Development”, “Applied Software Automation Tools”, “Programming Languages” and “Programming Language C++ for Controller Management”. Moreover, during the lectures, the academic staff devote special attention to the usage of technologies for solution of real tasks, thus ensuring that a programming engineer masters the required knowledge and skills as efficiently as possible.

As described in 3.2.6 “Analysis and assessment of the topics of the graduation papers”, the academic and scientific staff of the Institute of Applied Computer Systems (IACS) follow the latest trends in IT research and propose themes for the graduation papers corresponding to them, including the development of a software prototype or product for the real needs of the public or businesses.

Consequently, the aims, objectives, and learning outcomes of all parts of the study program lead to the achievement of the learning outcomes and the overall aim of the study program, as well as the fulfillment of the tasks. Regular analysis and updating of the study courses eliminate their possible overlapping and duplication. The mapping of the learning outcomes of the study courses against the program learning outcomes is given in Annex P08 “Mapping of study courses for the study program “Computer Systems””. The mapping indicates that the learning outcomes contributing most to the program outcomes are related to basic knowledge and key skills in computer science and software engineering: has acquired knowledge in computer science in general and its formal basis (supported by more than 100 learning outcomes), is able to choose the appropriate algorithms, methods, software products, and tools for solving problems (supported by more than 115 learning outcomes), is able to use software development environments and tools as well as to develop software according to the best practice and standards of the IT sector by observing a good programming style, using software environment and tools (supported by more than 90 learning outcomes) and is able to participate in project development, work in a team and plan work activities by observing public interests and sustainable development (supported by more than 80 learning outcomes). This is due to the fact that these four outcomes cover very broad and fundamental areas. At the same time, the mapping also indicates that the other six outcomes are also achieved through study courses included in the study program. The outcome “is able to study professional literature in a foreign language” are supported by 30 study courses, the outcome “ability to draw up software documentation in conformity with the industry standards by using correct professional terminology” are supported by outcomes of over 40 study courses, the outcome “ability to understand and analyze software design descriptions, requirement specifications, documentation and code of the maintenable system, as well as their changes” is supported by outcomes of over 45 study courses, the outcome “ability to think creatively, to develop new methods and approaches to problem solution with the help of computer systems” is supported by outcomes of over 35 study courses, the outcome “ability to mastering new models, methods and technologies, as well as be aware of the necessity of continuous professional growth” is supported by outcomes of over 20 study courses, and finally reaching of the outcome “ability to work independently in their professional field” is implemented by 60 study courses. Although reaching the outcomes of some study programs is ensured by a smaller number of outcomes of study courses, the ability of students to work independently in their professional field, to master new models, methods, and technologies, to think creatively, to analyze software design descriptions and requirement specifications is trained through practice only by rather large-scale projects, which are thus not numerous but sufficiently big in their volume. In addition, in bachelor studies, a student must first learn the fundamentals and only then build on this knowledge to create larger projects that train to master skills such as an ability to work in teams in their professional field.

Detailed descriptions of each study course are given in Annex P10.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Teaching methods, study course structure and assessment methods are selected by the responsible instructor, according to the study course curriculum and program specifics, as well as the needs of the students. The study work is divided into the following forms: lectures, practical classes, laboratory and independent work implemented individually and in groups, tests and graduation paper.

The aim of lectures is to ensure the acquisition of theoretical material of the study course. Hybrid teaching methods are used to achieve the learning outcomes, combining verbal teaching methods, explanatory teaching methods, interactive teaching methods and demonstrative teaching methods. Various forms of feedback are actively used during lectures, including modern IT solutions, which also assist in implementing of emotional stimulation and appreciation methods.

The aim of the laboratory work is to develop practical skills in the topics of the study courses using the laboratory equipment. In view of the professional focus of the study program, laboratory works are particularly important for the profound mastering of technologies. In laboratory work, the academic staff combine a variety of practical teaching methods, including instructional and productive methods, as well as methods of teaching skills and methods for the use and strengthening of creativity, to achieve the study course objectives. When planning laboratory works, the academic staff relates the theme of the task to the IT industry whenever possible, thus allowing students to consider the application opportunities of the mastered theme in the work environment.

The aim of independent and practical work is to strengthen the theoretical knowledge acquired at the lectures by applying it to the analysis and solution of various tasks, situations and problems. To achieve the objectives, the academic staff use similar methods to those used in laboratory work, supplemented by problem-oriented methods and learning discussions, but without the use of laboratory equipment.

Practical, independent and laboratory work is organised both individually and in groups, ensuring that students develop both their individual skills and the skills essential in the IT industry to work in teams, as well as to formulate and delegate tasks, and to present their results.

The purpose of tests is to assess how students have acquired the theoretical knowledge and developed the relevant skills. Depending on the knowledge and skills to be tested, the following forms of assessment are used: assessment tests, test work, examinations, and credit tests.

For graduation papers, the research method is mainly used, but the practical teaching method, the heuristic (discovery) teaching method, and the skill-building teaching method are also applied. To develop discussion and presentation skills, as well as to discuss and promote the results of the graduation paper, students are offered the opportunity to participate in RTU Student Scientific and Technical Conference.

In academic matters, an individual approach is ensured in accordance with RTU Academic Staff Work Planning Guidelines, which stipulate that the academic staff must ensure the availability of the necessary amount of counseling/tutoring to students. In addition, individual consultations are provided for the supervision of coursework and projects, internships and Bachelor Theses. Pre-examination counseling is organized before examinations. If necessary, students can directly contact academic staff outside the tutorial hours by sending their questions in the form of messages or in the appropriate course forum in ORTUS system or by e-mail.

RTU e-learning environment ORTUS based on Moodle platform is actively used to support the study process, which contains study materials, knowledge self-assessment tools, task submission functions, testing functions, as well as video recordings of lectures that are used during the remote studies. The use of the e-learning environment is mandatory for RTU academic staff. The plagiarism detection software developed by IACS is used for submitted papers. All resources available in the e-learning environment can be used by the student at their own pace and according to their individual needs.

The teaching methods tested at other study programs implemented by the Institute will be used to implement the study program in two languages - Latvian and English. It is planned that from 2023, the study program in the Latvian language will be mastered by the local students, while the study program in the English language will be mastered by foreign students. To ensure the quality of studies, academic staff with at least B2 level of English are involved in the work with foreign students.

RTU considers all aspects of student-centered education in order to increase students' motivation and improve the quality of their studies.

1. Student involvement in the study process and content development

In accordance with the procedures developed by RTU, students have opportunities to provide regular feedback on the study content. Students are regularly involved in the quality assessment of study programs and participate in the work of decision-making and advisory bodies. In addition to the formal processes, there are regular meetings between students and the head of study program to discuss the content and quality of the studies. There is a semesterly survey in which students give feedback on the study course as a whole. Students also have the opportunity to contact the head of study program or RTU Study Department at any time, where there is a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to software development and other IT processes, and link the outcomes to the study program learning outcomes and the study course volume in terms of credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (document, presentation, video recording, interactive learning materials, etc.). Students have the right to propose their own topic for the graduation paper, thus achieving the learning outcomes in an area that interests them.

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. RTU also regularly uses the opportunity to invite guest lecturers to share their experience with students in the form of individual guest lectures or complete study courses. By meeting guest lecturers in specially organized seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad. Further information on guest lecturers and academic staff mobility is given in section 3.4.1 "Assessment of the compliance of the qualification of the teaching staff members".

4. Social dimension

Students studying in the study program "Computer Systems" have sufficient flexibility to combine work/family life with their studies. This is demonstrated by the fact that most students have already started their working life in the 2nd or 3rd year of their studies. As a positive fact it should be noted that RTU library is available to students 24 hours a day and also at weekends.

5. Teaching and learning methods

The teaching and learning methods described previously are used in the implementation of the study program and are adapted by the academic staff to the specific situation. Students have the opportunity to receive individual tutorials from the academic staff involved in the study program, including communication in the e-environment using RTU licenses for Zoom and MS Teams platforms, as well as messaging services of the Moodle platform.

6. Learning environment

In 2021, a new FCSIT faculty building was opened on Zunda krastmala 10. Students have access to all the technical equipment needed for modern IT education - computer labs, including virtual computer labs. The new building has quiet working and relaxation areas on each floor. Modern videoconferencing tools such as Zoom and MS Teams licenses for remote lectures and tutorials, as well as other software licenses, including academic ones (e.g., MS Office, and various software development environments and tools) are also available. Classrooms also have the technical equipment to support hybrid learning, thus enabling foreign teachers to be involved in teaching a part of a course/lecture from a distance.

Throughout the implementation of the study program collaboration between librarians and academic staff is ensured, with the aim of improving the teaching and learning process. In the first year of studies, students are introduced to the resources and databases available in the library. Following the modern demand, RTU Scientific Library is digitalizing, offering more and more resources in e-format, including the most important databases of scientific articles in the IT field (IEEE, SpringerLink, ACM, ScienceDirect, Wiley, etc.).

7. Academic staff competence development

The academic staff involved in the study program are provided with regular opportunities to develop their methodological and didactical skills. The competence development process of academic staff includes methodological seminars of the Institute of Applied Computer Systems and the Faculty on the use of teaching and learning methods, including innovative teaching methods, as well as RTU Methodological Conference. The following methodological seminars have been held in recent years:

- 20.02.2019. Academic Integrity and Work with International Students;
- 18.12.2020. Organization of Remote Examinations;
- 12.02.2021. Implementation of Distance Learning;
- 12.03.2021. The Digital Age Student (Zanda Rubene, Professor, University of Latvia);
- 08.10.2021. Content of the Bachelor Thesis at the Institute of Applied Computer Systems;
- 28.01.2022. Academic Integrity at RTU and FCSIT;
- 25.02.2022. Formative Assessment: with and without technology (Anžela Jurāne-Brēmane, Researcher, Vidzeme University of Applied Sciences).

SAM 8.2.2 project provided the opportunity to do internships in IT companies, thus mastering the latest approaches and methods used in the industry in order to integrate them into study courses. The project also provided an opportunity to attract new academic staff, especially PhD students, to teach in the study program.

8. Extra-curricular activities for students

A wide range of extra-curricular activities are offered to the students of the study program:

- The study program and faculty management actively support and encourage students to participate in student self-government activities, thus allowing students to develop their independence, giving them the opportunity to implement their ideas, as well as opportunities for additional learning outside lectures.
- Every RTU student is offered opportunities to participate in extra-curricular activities (sports teams, dance groups, choirs, etc.) organized by several RTU departments.

- Students are also involved in scientific work and research on topics relevant to the field, participating in both local and international projects, which also gives them the opportunity to participate in international conferences.
- Each year, a Student Scientific and Technical Conference is organized, where students have the opportunity to gain first-hand experience in publishing their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Following mastering of theoretical study courses, students extend and consolidate professional knowledge in practice. The goal of internship is to provide students with practical activity experience required for obtaining professional qualification in IT field at a company or institution, or an IT department of an undertaking beyond RTU.

During the internship, students get acquainted with the company structure and its operation organization, as well as economic indicators of the undertaking. Students are provided with an opportunity to master the latest scientific and innovative technical solutions in the field of software engineering. Internship is organized during the final year of studies and its volume is 26 CP, of which 6 CP are obtained during the seventh semester and 20 CP during the eighth semester. The internship tasks, where activities to be performed and deadlines are provided, are formulated in accordance with the requirements of the undertaking and the study program and are monitored by the internship manager at the undertaking. During the internship, regular consultations with the internship manager at the undertaking and the internship coordinator at the university are scheduled in accordance with the instructions of the organizational unit. During the first part of the internship (6 CP), students master work in a team, including configuration of the work place/environment, clarifying the software requirements, design and implementation of the software (including unit testing), as well as investigation of the available technologies and selection and/or adjusting of the most appropriate one. Students draw up the project documentation in conformity with the software development project execution regulations. Results of the internship are publicly presented. The second part of the internship (20 CP) is anticipated for consolidating the previously obtained knowledge and improving practical skills in performing work tasks of a programmer at different processes of software development. Organization of the second part of the internship is similar to that of the first part. Results of the second part of the internship are executed in the form of a report in accordance with the instructions of the organizational unit and are publicly presented.

Organization of internship takes place in accordance with RTU Senate Resolution No. 626 adopted on 28 January 2019 “On the Internship Organization Procedure at RTU”. In addition to RTU Senate Resolution, the internship organization also follows the methodological instructions for the organization and implementation of the internship for the students of the professional bachelor study program “Computer Systems”. As mentioned in the Internship Organization Procedure, the internship coordinator at the organizational unit helps provide a place of internship for students. If additional assistance is required with finding a place of internship, it is possible to apply to RTU Career Support and Service Centre, where a career consultant and a project manager help students with searching for and arranging places of internship, as well as promote the development of career management skills with the help of different measures that can ensure successful results in the course of internship. Once a year, the Career Support and Service Centre organize RTU Career Day, within the framework of which students can meet in situ representatives of companies and communicate on their future career opportunities.

Internship at the already existing workplaces of students is also supported, which is possible in cases when the work tasks of the student at the existing workplace comply with the internship requirements.

Since 2015, students have access to an additional resource - a webpage where companies are invited to place their vacancies, which are relevant for RTU students (https://ekarjera.rtu.lv/). Students can connect with their university user password and follow topical internship and later also job opportunities in their sector.

Additional support in developing practical skills is provided by RTU Development Fund (https://www.rtu.lv/en/developmentfund). During a year, several hundred of practical skills promoting competitions are offered, organized in cooperation with undertakings, where students can obtain practical skills.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

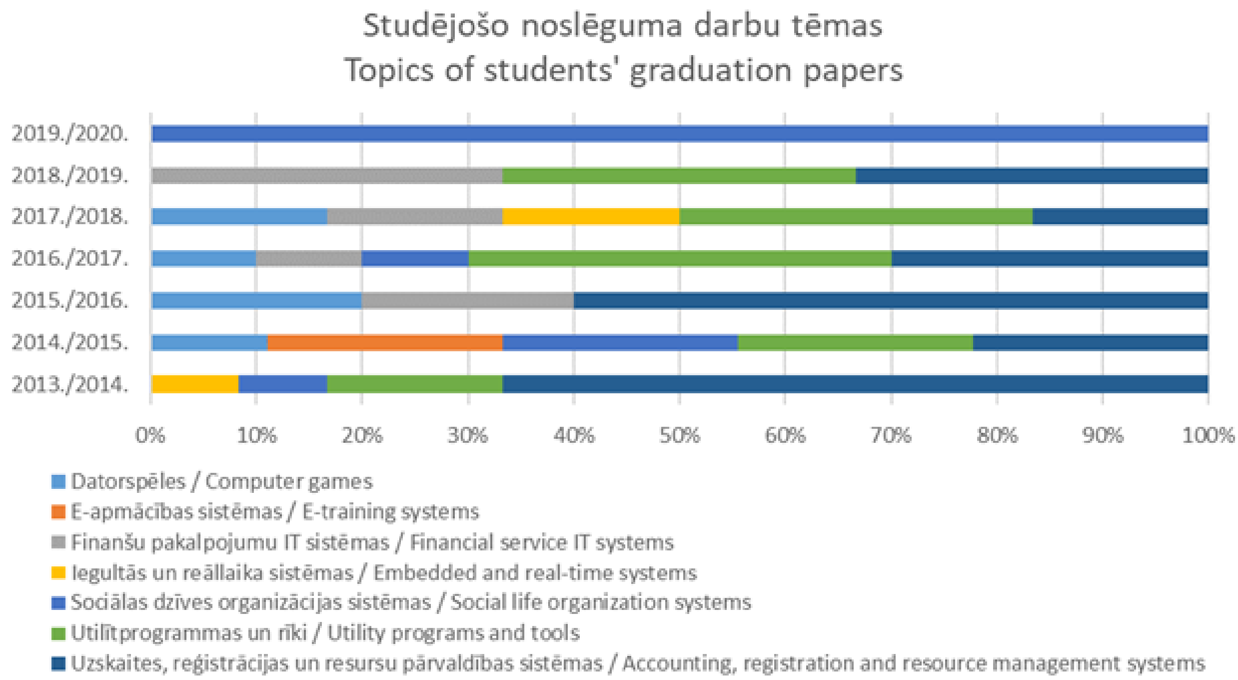
During the reporting period, 46 young professionals graduated from the study program, fully completing the program requirements and elaborating a graduation paper.

Students of the professional bachelor study program “Computer Systems” have to develop the Bachelor Thesis with a project part, which means that the Bachelor Thesis includes both topical technology research, usually with a goal of selecting the appropriate technology for solving a certain task, and development of the software product or prototype. Therefore, within the framework of the graduation paper, students confirm their skills both in technology analysis and selection, and in all tasks related to the software development. The Institute of Applied Computer Systems has productive cooperation with the sector undertakings; thus, many students develop their graduation papers on topics defined by the respective undertaking, which are currently topical in the sector. Students may select developing a software product or prototype according to their interests and in compliance with topical tasks in modern IT industry. Graduation papers are developed by creating solutions for the following fields:

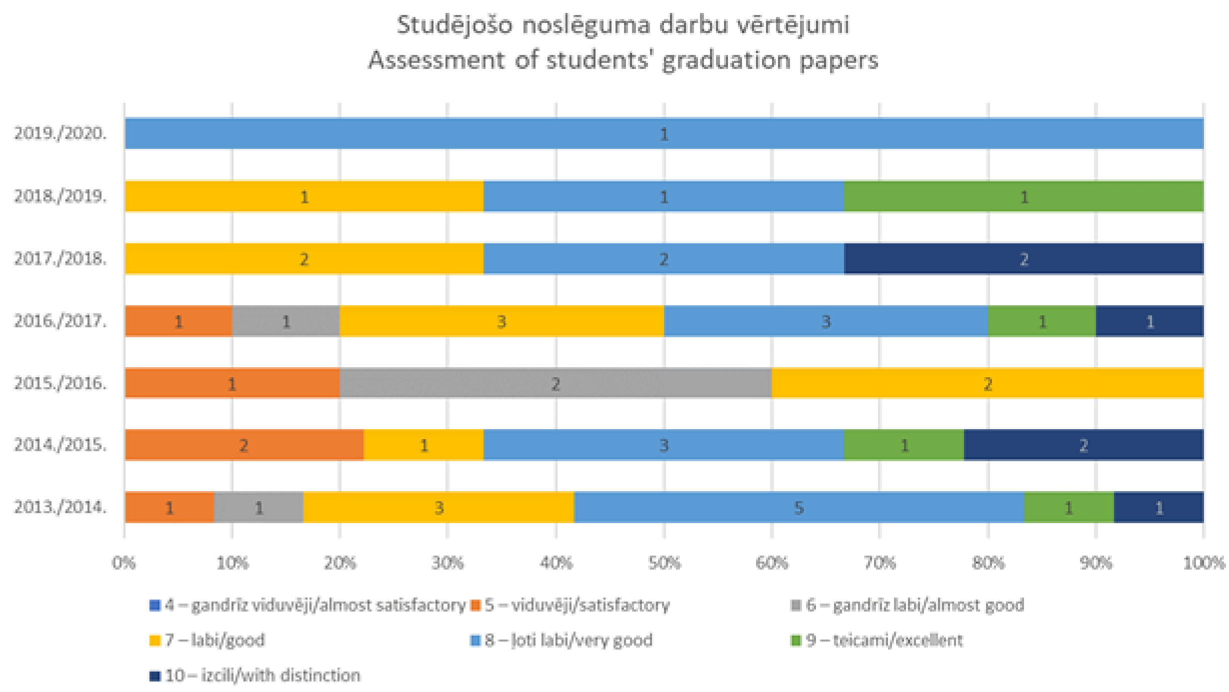
- **Computer games** – including mobile platforms (Android, iOS, multiplatform);
- **Accounting, registration and resource management systems** – transport, finances,

pharmacies, library, user authorization, user administration, different material, refrigeration equipment selection system, client relations management system;
- **Social life organization systems** – organizing student joint accommodation, city architecture guide, social network integration in a uniform platform, secondary school website, hockey team management system, film portal development;
- **Utility programs and tools** – file organizer, IT help and monitoring system, software testing, tracing journal management, machine translation technologies;
- **E-learning systems** – online learning system;
- **Financial service IT systems** – payment card processing system services, stock exchange stock data tracking system, cryptocurrency application;
- **Embedded and real-time systems** – equipment management, meteorological portal development.

The overall distribution of graduation papers by theme for each academic year is shown in the figure below. As it can be seen, most graduation papers are written in such areas as different accounting, registration and resource management systems, utility programs and tools, as well as computer games and different solutions intended for the financial sector. These areas are in good compliance with IT systems to be developed by Latvian IT enterprises and thus it can be concluded that students in their graduation papers develop systems for similar areas which they later will work on at their workplaces. The general list of themes by year and the grades obtained by students are given in Annex 3.2.6 “Topics of students’ graduation papers”.



Distribution of assessments obtained by students in each study year is provided in the figure below. Bachelor Thesis with a project part are mostly assessed as very good (8) and good (7). There are about the same number of assessments in the range excellent (9) – with distinction (10), as well as satisfactory (5) and almost good (6). Students have not received lower assessments in the reporting period. Therefore, it can be concluded that the distribution of assessments is close to a normal distribution, which is considered in pedagogy as an ordinary and good practice.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The following resources are used for the implementation of the study program:

- Auditoriums for lectures and practical classes. The study program is implemented at the Ķīpsala Campus, which has both FCSIT rooms and RTU joint use premises. The facilities are accessible for persons with disabilities. Available classrooms are described in Part II, Chapter 3, Section 2.3.2 - Resources and Provision of the Study Field.
- RTU information platform ORTUS and E-learning environment, which provide support function for information exchange between the faculty and students, the study process, available study course materials, posted and completed tasks, assessment tests, etc.
- Computer classes and computer labs, which are of particular importance given the specific nature of the program. The necessary software is purchased and installed in the computer labs appropriate for each study course, mostly academic licenses are used for specific software. 5 joint use computer classrooms (140 computers in total) are available at FCSIT and 5 specialized computer labs (150 computers in total) are available at the Institute of Applied Computer Systems. Windows, Linux, MAC and mobile computer classes are available. Computer labs provide students of the study program “Computer Systems” with equipment necessary for the development of group projects, laboratory works and research during their studies.

- FCSIT joint use computing center, which provides access to computing resources in the cloud. Virtual computer labs are also available for students to use specific software remotely. Licensed Microsoft office software and software development tools are also available to students for learning purposes.
- Virtualization services that allow students to obtain the computing resources they need for various tasks and experiments with the appropriate software and infrastructure, including a fixed internet connection.
- In 2015 FCSIT opened the National Research Centre of Information, Communication and Signal Processing Technologies, where students have the opportunity to join program-relevant research in fundamental and applied research in computer systems development, in particular but not limited to the development of their Bachelor Thesis.
- RTU HPC provides necessary computing power for resource demanding student research, for example, training deep neural networks.
- RTU Scientific Library.

The computer class equipment used in the study programme provides the full performance of laboratory and practical work using the current technical provision. A wide range of operating systems and technical solutions (Microsoft, Linux, Apple products) provides option to observe the operating and processing principles of software in different environments.

Mobile class (Android based devices) gives option to use digital materials and knowledge testing tasks during lecture time (interactive interaction tools that require predesigned configuration and increase the level of reliability of the identity of the task or knowledge test accomplished in the learning process).

IACS virtualization solutions provide option to integrate students' computers into the learning process, using a cloud-based solution available to students with a predesigned configuration that reduces the time for preparing the computer for performing a task.

In the study year 2018/2019, the computer classes and laboratory premises of the Institute of Applied Computer Systems for training and scientific research were occupied for 90% of available time.

RTU Scientific Library has a wide range of books and other resources appropriate for the professional bachelor study program “Computer Systems” (description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3.). Upon request of the administration of the study program “Computer Systems”, 295 new books have been purchased in the period 2013-2021 for the amount of EUR 16,024.64.

Part II, Chapter 3, Section 2.3.3 lists the e-resource collections available in RTU Scientific Library. The content of the following collections is most relevant to the specific nature of the study program Computer Systems: ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost Web, ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate), learning materials repository Merlot, Latvian Standards Database (available only in the library premises). There is also an interlibrary loan and resource sharing system, ExLibris, where students can order books and journals that are available in other libraries.

Wireless Internet connection is available to students in all RTU premises, which enables students to study additional materials, participate in various interactive activities during the lectures, such as polls. The Institute of Applied Computer Systems also has the necessary equipment and software licenses for remote work with students, as well as the possibility to provide hybrid work, where some students are in the lecture room and some connect to the lecture remotely.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

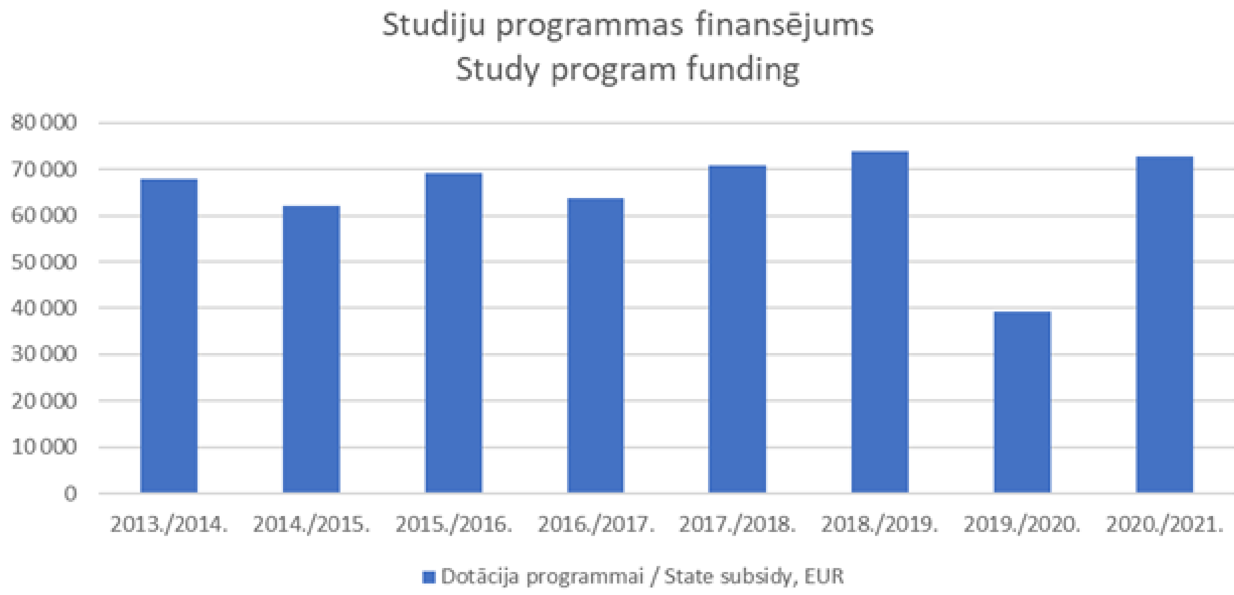
3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and facilities meet the conditions for the implementation of the study program and contribute to the achievement of the learning outcomes. The professional bachelor study program “Computer Systems” is implemented as a state budget financed study program with 17 state budget funded seats.

The data on funding are presented in the table below:

Study Program Funding

Academic year	State subsidy, EUR	Local student tuition fees, EUR	Total study program funding, EUR	Funding of one state budget funded seat, EUR
2013/2014	67 800	0	67 800	3 866
2014/2015	62 098	0	62 098	3 866
2015/2016	69 296	0	69 296	3 866
2016/2017	63 851	0	63 851	3 866
2017/2018	71 009	0	71 009	4 041
2018/2019	73 985	0	73 985	4 230
2019/2020	39 252	0	39 252	4 405
2020/2021	72 858	0	72 858	4 463



As shown in the table and the figure above, the volume of financing for the professional bachelor study program “Computer Systems” has not changed significantly in the reporting period, mostly due to the fact that students have been admitted to the programme on state budget funds and the number of state budget funded seats has not changed considerably.

Based on the 2015 “Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation”, as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study program, RTU has determined that the professional bachelor study program must have at least 19 students in each academic year. In the specific study program, up to now studies have been implemented only during three semesters, where the number of students, during the reporting period, has been on average 15, 4 and 13, respectively. This number can be explained with the fact that currently only applicants with the first-level professional (college) education are enrolled in the study program. The program could still be implemented with account of the fact that its biggest proportion is composed of internship and graduation paper. However, to increase the number of students at the program, it is planned to open admission in a full version of the program – 8 semester studies, as well as to implement the program in English.

Information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the cost per student is given in the Annex “Breakdown of funding between cost items”. Information on the minimum number of students required for the study program is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study program”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on

how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study program comply with the conditions for the implementation of the study program and the requirements of the regulatory enactments. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The responsible instructor is appointed by the head of the responsible structural unit. Instructors responsible for study courses can be professors, associate professors and assistant professors with a scientific degree in the relevant branch or sub-branch of science. The instructor responsible for the special study courses of professional study programmes can also be assistant professors without a scientific degree and lecturers with appropriate and sufficient practical work experience for the relevant study course. The study courses of these responsible instructors cannot be used in academical study programs. All responsible instructors involved in the implementation of the study program “Computer Systems” hold a PhD degree. In total, 66% of the academic staff involved in the implementation of the study program hold a PhD degree. All lecturers have at least a Master’s degree in engineering or computer science, while practical and laboratory work is mostly carried out by academic staff with Master’s degree, but in some cases industry professionals with the necessary practical experience are involved. In total, 61 academic staff members are involved in the implementation of the study program.

Elected academic staff participate in the implementation of the study program, the election of which and the observance of the necessary quality requirements are regulated by the RTU Regulations No. 589 adopted on April 27 2015 “Regulations on the Procedure for Election of Docents, Lecturers and Assistants” and No 649 adopted on April 26 2021 “Regulations on the Procedure for Election of Professors or Associate Professors and Qualification Assessment of Professors and Associate Professors”, as well as the Rector's order on the procedure for evaluating the performance of professors and associate professors (No. 01000-1.1-e / 157 of 7 October 2021).

The number of PhD holders has increased during the reporting period. During the reporting period, four academic staff members of the study program “Computer Systems” have obtained their PhD degree - Assoc. Professor Aleksejs Jurenoks, Assist. Professor Gusts Linkevičs, as well as researcher Ēvalds Urtāns who is the instructor of free elective study courses.

In study courses and topics where the IACS team lacks expertise, guest lecturers from IT companies are involved. Examples are summarized in the table below. The number of academic staff involved in the implementation of the study program is 61; the number of guest teaching staff is 4 (total during the reporting period).

Summary on the involvement of the guest lecturers in program implementation:

Name, surname of the guest lecturer	Organization	Date	Study course, activity	Contact hours

Zigmunds Buliņš	Ltd “innoForce”	2014/2015 2015/2016	“Safety of Information Systems”, conducting lectures and laboratory works	32
Intars Garbovskis	Accenture Latvia	2017/2018 2018/2019	“Safety of Information Systems”, conducting lectures and laboratory works	32
Aleksejs Grocevs	Ltd AGandPals	13.11.2018, 27.11.2018	Lecture “Prototyping of Fast Web Usage with SpringBoot” within the study course “Modern Programming Languages and Platforms”	2
Pāvels Jeļisejevs	C.T.CoLTD	13.11.2018	Lecture “How to Become a Better Developer” within the study course “Modern Programming Languages and Platforms”	2

To ensure and improve the quality of studies, academic staff of FCSIT actively participate in various professional advancement activities. Training and qualification improvement are carried out through the participation of academic staff in conferences and seminars, studying in various courses, participation in the work of other organizations, practical work as experts and consultants. RTU provides access to edX and Coursera study courses in the areas of interest to the academic staff. RTU organizes an annual methodological conference, which is regularly attended by the academic staff of the Institute of Applied Computer Systems as listeners and presenters.

A particular highlight is the Buffalo Program, launched in 2019, which brings academic staff members to the State University of New York at Buffalo, USAfor a semester-long internship. Currently, the following academic staff members of the professional bachelor study program “Computer Systems” have completed the internship process: Professor Marina Uhanova, Associate Professor Alla Anohina-Naumeca, Associate Professor Katrina Boločko, lecturers Andris Ozols, Ainārs Auziņš and Kārlis Berkolds. For the academic staff members involved in the implementation of the study program there is also an opportunity to undertake internship in Latvian IT companies within the SAM 8.2.2 project.

The compliance of academic staff with the requirements for the implementation of study courses is confirmed by the data included in the CVs of academic staff and their research results (scientific projects, publications, presentations at scientific conferences, as well as contractual work). In accordance with the Law on Higher Education Institutions, academic staff also carry out research activities in the relevant field at the same time as their work in the study process. Academic staff are free to choose their field of research and to propose appropriate topics for graduation papers. In 2021, International Evaluation of Scientific Institution Activity, RTU Faculty of Computer Science and Information Technology was awarded a four-grade rating.

~70% of the elected academic staff of the Institute of Applied Computer Systems hold a PhD. A number of academic staff members are also employed in IT companies and thus transfer practical skills and competences to the study program.

Brief summaries of the academic staff activities are given below.

Assoc. Prof. Egons Lavendelis

Head of the study program “Computer Systems”. Research in artificial intelligence, focusing on multi-agent systems, software for control of multi-robot systems based on intelligent agents and systems theory. E. Lavendelis has 42 publications in the corresponding field of research (14 of them in the last 6 years) and has participated in 18 research projects (7 of them in the last 6 years), including FP7 and ERA-NET international projects, and has been a scientific leader or RTU research team leader in 3 projects.

Assoc. Prof. Alla Anohina-Naumeca

Primary research area: intelligent learning systems that use artificial intelligence methods to ensure personalised learning process. She has published three research papers in this area in the last six years. She has completed a contract with the IT Education Foundation to develop the content structure of a free online open access study course in artificial intelligence, and at RTU has developed a massive open online course in artificial intelligence, “Artificial Intelligence: Search and its Applications”. In 2020, she completed AI-related courses demonstrating the highest results during her internship at the State University of New York at Buffalo, USA. She has obtained certificates in professional advancement courses “Artificial Intelligence for Everyone” (Coursera), “Elements of Artificial Intelligence” (University of Helsinki) and “Mind and Thinking from a Cognitive Science Perspective” (UL Open Minded).

Prof. Jānis Grundspeņķis

Implements study courses related to artificial intelligence and systems theory. His latest research involves work on four projects: complexity analysis of concept maps from a systems theory perspective, the use of ontologies in competency management, future robotics technologies, and event-based computer vision.

Prof. Oksana Ņikiforova

Within the context of the topics of the implemented study courses (software design and development technologies, innovative product development and entrepreneurship, etc.) she has published more than 100 scientific articles and has participated in more than 30 scientific projects, as well as has long-standing industrial experience in software development projects.

Prof. Mārīte Kirikova

Scientific interests are mostly related to requirements engineering. Research focuses on models for reflecting information system context and developing continuous requirements engineering frame to ensure elasticity for the requirements engineering process. The latest studies are related to inclusion of data analytics in the requirements engineering process. During the last six years, she participated in 4 international and 5 local projects. Research results of the past six years are reflected in over 75 publications.

Assoc. Prof. Gundars Alksnis

His experience and competence in using programming languages C# and .NET, participating in the implementation of the professional bachelor study course “Visual Programming Fundamentals (study project)” and professional master study course “Visual Programming (study project)” since 2010 help develop student competences in visual programming making programming more efficient. Programming experience in visual programming was gained from the previous work in the IT industry.

Assoc. Prof. Katrina Boločko

She is the author of eight scientific articles and worked on five scientific projects related to the subjects of her study courses (computer graphics and computer vision). For the purpose of professional advancement, she participated in the Buffalo program for Latvian academic staff, during which she attended courses related to image processing and computer vision.

Prof. Marina Uhanova

In the last six years, she has published 12 scientific articles and participated in one scientific project related to the study courses she implements (algorithmization and solution programming, programming in computer network environment). In 2019, she completed an internship at the State University of New York at Buffalo, USAfor the purpose of professional advancement, and mastered three Coursera courses: “Text Retrieval and Search Engines”, “Programming for Everybody (Getting Started with Python)” and “Python Data Structures”.

Assoc. Prof. Pāvels Rusakovs

In the last six years, he has published three scientific articles dealing with some of the problems of the Semantic World Wide Web and the use of video steganography for copyright protection.

Assoc. Prof. Natālija Prokofjeva

She conducts research on assessing student knowledge and personalizing e-learning. She has participated in professional advancement courses “Methodology of teaching the module of new product creation and development” and “Conflict resolution skills”. She is the author of 24 scientific articles on the issues of improving the learning process.

Lect. Svetlana Jurenoka

She has published three scientific articles in the last six years. For the purpose of professional advancement, she completed four Coursera courses (“Introduction to Artificial Intelligence”, “Software Development Lifecycle”, “Software Product Management”, “Excel/VBA for Creative Problem Solving, Part 2, Part 3”) and a Future Learn course “Artificial Intelligence for Earth Monitoring”.

Assist. Prof. Imants Gorbāns

In the last six years, he has published three scientific articles related to his study courses (operating systems). In 2020, he received a certificate for the Coursera course “Google Professional Certification - IT Security: Defence against the digital dark arts”.

Sen. Researcher Andra Blumberga

A. Blumberga is an expert in system dynamics modelling for macroeconomic research on energy efficiency and renewable energy sources. Author of more than 130 scientific articles, she works on various regional and international projects focused on efficient use of natural resources, increased energy efficiency, and environmental protection in buildings and the energy sector.

Prof. Andrejs Koliškins

In the last six years, he has led one research project and published 21 scientific articles related to the study courses he implements (tasks on the stability of fluid flows requiring the use of numerical methods: calculation of eigenvalues and numerical solution of ordinary differential equations).

Sen. Researcher Ilmārs Iltiņš

In the last six years, he has participated in two research projects and published five scientific articles related to the subject of the study courses he delivers (numerical methods).

Lect. Jānis Amoliņš

Within the State Education Development Agency project “Adult Education”, he implemented a web development study course that includes the entire software development cycle and documentation.

He has worked in the industry on software development projects, which allows him to explain students not only the theory but also the practices used in the industry.

Prof. Inta Volodko

Participated in the Latvian Council of Science project “Analysis of complex dynamical systems in fluid mechanics and heat transfer”. In the last six years, she has published 27 scientific articles, 17 of them related to the teaching of mathematics at the university level. Teaching skills have been improved by attending the course “Introduction to Engineering Pedagogy” at Tallinn University of Technology.

Lect. Ainārs Auziņš

In the last six years, he has published three scientific articles and participated in two research projects. Professional advancement: RTU, RBS and UL courses financed by the European Regional Development Fund, project “Support for RTU international cooperation projects in research and innovation in the State University of New York at Buffalo, USA. Topics mastered: DBMS, Big Data Technologies.

Assoc. Prof. Jeļena Pundure

Research field: social and economic geography, economics and entrepreneurship. From 2015, she is an expert of the Latvian Quality Agency for Higher Education. Head of the ERASMUS+ project “Needs-based education and studies in societal security”. Researcher of INTERREG project “Development of a common environmental risk plan for Jelgava and Šiauliai”. In the last six years, she has published 13 scientific articles. Regular participant in professional advancement seminars (more than 30 in total).

Prof. Elīna Gaile-Sarkane

In total, the author of over 100 scientific works, including two scientific monographs and two patents. The author of two textbooks. She is a member of the editorial board of scientific journals, as well as is the author of over 50 scientific articles (Scopus Hirsch index 7) published in journals and collections of articles of scientific conferences. Pedagogical work: has successfully supervised six Doctoral Theses, reviewer of several Doctoral Theses and a scientific consultant. She delivers courses in innovation management, change and strategic management, undertaking and entrepreneurship management and other areas. LZP expert in two subbranches of social sciences; Chairperson of the Promotion Council “RTU P-09”.

Assoc. Prof. Natālija Prokofjeva

Conducts research in student knowledge assessment and e-training personalization. Participated in pedagogical qualification upgrade courses “New Product Creation and Development Module Training Methods” and “Conflict Situation Solution Skills”. During the last six years, she published 24 scientific articles devoted to the study process improvement issues.

Assoc. Prof. Aleksejs Jurenoks

During the last six years, he developed and published 18 scientific articles. Participated in three international projects and one national research project. Upgraded his qualification at Aristotle University of Thessaloniki in Greece, Malaysian Institute of Information Technology in Malaysia, Technical Military Academy of Bucharest in Romania, and National University of Singapore in Singapore. Since 2006, he has been delivering different courses in computer science at several bachelor and master level study programs of RTU, and supervises Master and Bachelor Theses. Scientific research activity is related to the development of methods for extending the service life of wireless sensor networks. Participated in different workgroups for developing the occupational standards; member of international conference organization and program committees.

Prof. Agris Ņikitenko

In the last six years he has authored 15 scientific articles and participated in 4 scientific projects.

Assist. Prof. Aleksandrs Kovancovs

During the last six years, he developed and published 12 scientific articles.

Lect. Kārlis Berkolds

During the last six years, he developed and published one scientific article. One of the authors of the "Introduction to the IoT" book published in 2019.

Assist. Prof. Jānis Eiduks

During the last six years, he developed and published 5 scientific articles.

Lect. Valdis Saulespurēns

In the last six years he has participated in one scientific project.

Assist. Prof. Jevgenijs Kaupužs

During the last six years, he developed and published 7 scientific articles.

Assist. Prof. Aleksandrs Matvejevs

During the last six years, he developed and published 8 scientific articles.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

One of the challenges that had to be addressed during the reporting period has been to renew the academic staff, which has been achieved by replacing retiring colleagues with new qualified academic staff. At the start of academic year 2016/2017, the average age of the elected academic staff of the Institute of Applied Computer Systems was 49.8 years, while at the start of the academic year 2021/2022 it was already 47.7 years. However, the overall structure of the academic staff during the reporting period is considered to be stable.

Generally, young colleagues start their career at the Institute of Applied Computer Systems already during their studies (final semesters of bachelor studies or master studies) by getting involved in one of the research projects implemented at the Institute. Students who perform well during their studies are offered the opportunity to continue their studies in the PhD program and to get involved in the teaching process, initially as assistants, and later during their PhD studies as full-fledged lecturers for undergraduate students. This mechanism of attracting new academic staff has proven to be very useful in terms of assessing potential candidates during their studies and reaching out to students with the qualities and skills required for academic work.

Currently, 18 of the 26 elected academic staff members at the Institute of Applied Computer Systems hold PhD degree, representing ~70% of the elected academic staff.

The field-specific study courses are mostly implemented by the academic staff of the departments within the Institute of Applied Computer Systems, whose composition has undergone relatively little change. The changes have been made with one of two objectives:

1. to change the academic staff of a study course in order to improve or modernize the content of the study course. Such changes are based on student feedback and evaluation of the course content.
2. to change the academic staff of a study course who is temporarily or permanently unavailable for the implementation of a particular study course for any reason due to retirement, change of job, or other reason.

Regardless of the reason for the replacement, it is taken into account that the quality of the implementation of the study course must not be reduced by the arrival of new academic staff. This ensures the quality of the implementation of the entire study program.

At the Department of Artificial Intelligence and Systems Engineering (at the beginning of the reporting period referred to as the Department of Systems Theory and Design):

- to reduce the workload of Professor Jānis Grundspeņķis, the study course “Introduction to Study Field” is implemented by Assoc. Professor Alla Anohina-Naumeca. No significant changes in student feedback have been observed.

At the Department of Software Engineering:

- Instead of Professor Jurijs Lavendelis, the study course “Algorithmization and Programming of Solutions” is implemented by Professor Marina Uhanova. The new skills and competences acquired by Marina Uhanova were used, which were acquired during the participation in so-called "Buffalo" program, which provides academic staff training at the University of Buffalo, USA. Since the change of the teacher, a markedly positive change in student feedback has been observed.
- The study course “Algorithms and Methods of Programming”, where Professor Jurijs Lavendelis is the responsible instructor, is implemented by lecturer Valdis Saulespurēns. Since the change of the teacher, a markedly positive change in student feedback has been observed.
- Instead of Professor Larisa Zaiceva, the study courses “Software Engineering” and “Bachelor Thesis Including Project” are implemented by Assoc. Professors Natālija Prokofjeva and Aleksejs Jurenoks, respectively. No significant changes in student feedback have been observed.
- Instead of Assoc. Professor Eleonora Latiševa, the study course “Operating Systems” is implemented by Assist. Professor Imants Gorbāns (formerly Guest Assistant Professor). No significant changes in student feedback have been observed.
- Instead of Assoc. Professor Vjačeslavs Šitikovs, Assoc. Professor Aleksejs Jurenoks is responsible for the study courses related to Applied Software Automation. No significant changes in student feedback have been observed.
- Instead of lecturer Jekaterina Bule, the study course “Programming Languages” is implemented by Assoc. Professor Aleksejs Jurenoks together with the lecturers Normunds Kante and Ēvalds Masaļskis. No significant changes in student feedback have been observed.

There have been no changes in the team of leading academic staff at the Department of Applied Computer Science. Along with the change of the head of the department, Associate Professor Gundars Alksnis was nominated the responsible instructor at the study course “Bachelor Thesis Including Project”.

The general foundations of computer science are provided by other departments of the Faculty of Computer Science and Information Technology. Main changes:

- Instead of Professor Aleksandrs Glazs, the study course “Fundamentals of Computer Graphics and Image Processing” is implemented by Associate Professor Katrina Boločko.
- Instead of Professor Ilmārs Iltiņš, the study course “Numerical Methods” is delivered by Professor Andrejs Koliškins.
- Associate Professor Dmitrijs Bļizņuks was appointed responsible for the study course “Computer Networks” instead of Professor Valērijs Zagurskis.
- In 2020, a field expert, lecturer Andris Ozols was recruited for the implementation of the study course “Innovative Product Development and Entrepreneurship”, which allowed enriching this study course with the practical experience of the lecturer. Following these changes, the course was also included in the professional study program “Computer Systems”.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

The fundamentals of engineering, as well as study courses in humanities, are provided by other RTU organizational units:

- Instead of Assoc. Professor Alvars Baldiņš, several study courses of the humanities block are implemented by Assist. Professor Aleksejs Šņitņikovs.
- Professor Juris Blūms was appointed responsible for the study course “Physics” instead of Professor Artūrs Medvids.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

At the same time, rigorous quality control is applied to the implementation of the study courses. The primary source of information is student feedback. Trust-based cooperation with the student self-government has been established so that students can approach not only the head of the study program but also their peers in the student self-government, who in their turn inform the head of the study program. All student complaints are promptly assessed and discussed with the academic staff. If it is found that the academic staff is unsuitable to implement the study course in question, new academic staff members are sought.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project

managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

When defining the curriculum of a study course, the responsible instructor, in collaboration with the head of the study program, assesses the role of the study course in the study program, considering the required background knowledge and providing the necessary foundations for the subsequent courses. All changes in the study program, as well as significant changes in the study courses, are discussed in the Council of the Institute of Applied Computer Systems, which is composed of the heads and representatives of all departments within the Institute. Representatives of each organizational unit consider proposed changes from the perspective of their unit's courses. As soon as a link between study courses is identified, a working group is set up, involving the head of the study program, the responsible instructors of all the courses involved and, where appropriate, the heads of the departments implementing the courses. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The result is that the responsible instructors of all study courses are informed about the curriculum and expected learning outcomes of thematically related study courses, thus avoiding overlapping between the study courses and also the omission of important topics from any of the courses in a given field. Changes to the general part of the study program, which does not comprise field-specific study courses, are discussed with the heads of the departments or responsible instructors of the study courses concerned. The academic staff involved in the study program implementation are informed about the role of their study courses in mastering the skills and competences defined in the occupation standard of a Programming Engineer.

In order to get a precise idea of the curriculum, teaching methods and terminology used in colleagues' courses, it is possible to attend their lectures. In order to ensure quality, the study courses are peer observed by another lecturer, thus taking over the good practices and providing feedback to the study course implementer. Open lectures are also organized for the academic staff. Methodological seminars are regularly organized at both Institute of Applied Computer Systems and the Faculty level, where academic staff share their positive experience, which helps all academic staff to cope with new challenges. One of the situations when this was particularly relevant was the transition to remote studies at the beginning of the COVID-19 pandemic. In addition to the new circumstances, academic staff also share their experience on other issues such as students' academic integrity, graduation papers, conflict resolution, changes in the approaches of today's young people to their studies, work with the employed students, etc.

In response to the changes in the procedures, official documents, organization of studies the most appropriate approach to the nature of the change is chosen, for example by organizing an information seminar or sending out detailed information about the changes and who to contact for further information.

In general, new academic staff start their academic career at the Institute of Applied Computer Systems by supervising practical and laboratory work or assisting at the lectures. Initially, new academic staff work under the guidance of experienced colleagues, meeting regularly with the responsible instructors to coordinate the content of the classes and the teaching methods to be used, thus ensuring knowledge transfer between the academic staff involved in the implementation of the study program.

All academic staff involved in the implementation of the study course have access to teaching materials prepared by the responsible instructor, which can be used both in the classroom and in e-learning courses. Responsible instructors and other experienced academic staff members are also available for consultation on pedagogical methods to be used in the courses, as well as on other issues that young academic staff members have.

The head of the study program monitors the implementation of the program and the cooperation between the academic staff. One of the tools for identifying problems is student survey that is conducted every semester. If students point out deficiencies in this survey, the head of the study program organizes a meeting between all the academic staff involved with the aim of finding a solution to the problem.

The study program is implemented by 40 academic staff members who hold a PhD degree, including 14 professors and 11 associate professors. Until now, the study program has been implemented only with students who had already obtained the 1st level higher professional education, therefore the real number of involved teaching staff is smaller - 37 and the number of students per academic staff in the study program is 0.84.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DCD0(42526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DCD0(42526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DCD0(42526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DCD0(42526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DCD0(42526)_CompliancewiththeStateEducationStandard_ProfBak_ENG.pdf	P06_3.2.1_DCD0(42526)_AtbilstibaValstsStandartam_ProfBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_DCD0(42526)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf	P07_3.2.1_DCD0(42526)_AtbProfStand_LV_ComplOccupationalStand_ENG.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DCD0(42526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DCD0(42526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DCD0(42526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DCD0(42526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DCD0(42526)_StudyCoursesdescr_ENG.zip	P10_DCD0(42526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_DCD0(42526)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_DCD0(42526)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Logistics and Supply Chain Management (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Logistics and Supply Chain Management*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Andrejs*
Surname of the study programme director	*Romānovs*
E-mail of the study programme director	*andrejs.romanovs@rtu.lv*
Title of the study programme director	*Doktors*
Phone of the study programme director	*67089514*
Goal of the study programme	*The goal of the programme is to educate professionals able to understand and implement logistics systems technology, as well as identify, analyze and solve problems in logistics systems and supply chains, related to their design, implementation, operation and management, including logistics information technology and systems, and to develop students' ability to carry out scientific work, participate in local and international projects and continue doctoral studies.*
Tasks of the study programme	*• To develop students' systems thinking ability and their skills needed in the area of logistics systems and supply chain management • To use fundamental and classical solutions along with recent scientific achievements, including information technology, providing effective solutions of various problems in logistics systems and supply chains • To provide students with knowledge and experience from different scientific areas by cooperating with staff from different European universities • To provide staff and students mobility within the partner universities • To ensure the flexibility of the study programme and possibility to modify it in order to follow changes in the labor market and new developments in technologies • To encourage students to participate in scientific research • To prepare and motivate students for further Doctoral studies*

Results of the study programme	*• Ability to solve problems of logistics systems and supply chains by taking into account general management concepts, human resources, environmental issues as well as technological and economic aspects • Ability to identify problems in the area of logistics systems and supply chains and evaluate their complexity • Ability to select and apply suitable methodologies and technologies to solve problems in the field of logistics systems and supply chains • Ability to evaluate different alternatives and select the solution to be implemented in the field of logistics systems and supply chains • Ability to elaborate solid arguments to convince and motivate decision makers, select the proper supply chain partners and then plan and coordinate the project to implement the solution • Ability to develop solutions to specific problems, by using modern information technology in the field of logistics systems and supply chains • Ability to choose the best transportation solution for the problem in the field of logistics systems and supply chains • Ability to use modern engineering and technology solutions for specific problems in the field of logistics systems and supply chains • Ability to acquire new knowledge and skills independently • Ability to justify advantages or disadvantages of a particular problem solution to the customer or other specialist • Ability to follow the rules of ethics within the scope of one's authority • Ability to participate in local and international scientific projects as well as lead them • Ability to study at postgraduate level.*
Final examination upon the completion of the study programme	*The final examination consists of the defense of a Master Paper and a test in fundamental and special areas of knowledge. Master Paper is defended in front of a special examination commission meeting, with the opportunity for the representatives from partner universities to participate in the work of the commission (either in person or teleconference mode). The learning outcomes in Master Paper are evaluated according to 10 grade system according to the Regulations of RTU (Studiju rezultātu vērtēšanas nolikums RTU, 2010. gada 29. marts, protokola Nr. 539).*

Study programme forms

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*

Admission requirements (in English)	*Bachelor degree in engineering science or natural sciences or social sciences (economics, management), or professional bachelor degree in the mentioned fields of science, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master’s Degree of Engineering Science in Logistics and Supply Chain Management*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

In April 2020, the head of FCSIT ITI Modelling and Simulation Department, assoc. prof. Andrejs Romānovs was appointed to head the study programme “Logistics and Supply Chain Management”. He has actively participated in the development of this programme throughout the two-year period from 2007 – 2009 in the framework of the European Commission programme “Lifelong Learning Program” and the sub-program project 134522-LLP-1-2007-1-ES-ERASMUS-ECDSP “Master in Logistics and Supply Chain Management”.

The statement of admission requirements has been specified to harmonize it with other programmes within the study field: Bachelor Degree in Engineering or Natural Sciences or Social Sciences (Economics, Management) or a Professional Bachelor Degree in the fields of practical activity corresponding to the named fields of science or equivalent education..

Other main parameters of the programme - implementation language (English), implementation type (full-time intramural) and the granted degree in the reporting period have not changed.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study programme “Logistics and Supply Chain Management” conforms with the strategical aims and tasks of the RTU study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, which envisages the provision of a high-quality study process, excellent research, sustainable valorization, and smart digitalization.

The name of the academic Master study programme accurately characterizes the study field, the aim and the learning outcomes of the study program. The student of the programme acquires the necessary knowledge, skill and competence to perform comprehensive and effective activities in the field of logistic systems and supply chains – understands and is able to implement logistics system technologies, to identify, analyze and solve problems in the field of logistics systems and supply chains related to design, implementation, operation and management of logistics systems and supply chains, also in the field of logistics information technology and systems, which provides the basis for further studies to acquire knowledge and skills in the next education cycle.

The study programme is an engineering program, it pays special attention to engineering solutions and technologies that are used in the field of logistics systems and supply chains. After mastering these solutions and technologies within the compulsory study courses, students master their practical use is specialization study courses. For this purpose, compulsory elective subject section offers two specializations in accordance with the agreement (see attached file *LSCM_Sadarbibas_ligums_Cooperation_Agreement*) between RTU and Autonomous University of Barcelona (UAB, Barcelona, Spain) and University of Applied Science Wildau (UASW, Germany), that are related to the logistics information (RTU) or cargo management (UASW) technology use. The code of the study programme is 45526 in the group of “Other engineering education programs” within thematic field “Engineering and technology education”.

The volume of the study programme is 80 CP and duration of studies is 2 years, which complies with the Cabinet Regulation No 240 13 of May 2014 “Regulations on the Standard of State Academic Education”. Such duration and volume of the programme allows to further improve the knowledge and skills acquired in the undergraduate studies and to allocate enough time for the scientific research work throughout the development of the Master Thesis. The realization of the programme conforms with the requirements of part two of Section 55 of the Law on Higher Education Institutions (see statement of the Council of Higher Education Nr.02000-2.2.1-e/15 in Annex 29).

The students admitted in the programme shall have a Bachelor’s degree in engineering or natural sciences or professional Bachelor’s degree in the relevant practical operation fields in the mentioned fields of science, or compatible education.

The tasks of the study programme:

- to develop students’ systemic thinking and practical skills that are necessary in the field of logistics systems and supply chain management;
- to use both fundamental and classic solutions and the newest achievements in the study process, including information technologies that provide effective solutions for several problems in the field of logistics systems and supply chains;
- to provide knowledge and experience from different fields to students by cooperating with academic staff from different European universities;
- to provide for the mobility of students and academic staff at the partner universities;
- to provide sufficient flexibility of the study programme in order to adjust to the changing requirements of the labor market and technological changes;
- to encourage students to take part in scientific research;
- to train and motivate students for further PhD studies.

In accordance with the setting of the study field, the obtainable degree is a Master’s Degree of Engineering Science in Logistics and Supply Chain Management.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The field of logistics and supply chain management is one of the most rapidly growing fields in Latvia and worldwide. In the activity area “Technological Environment and Services” of the Latvian National Development Plan, transportation and logistics services are mentioned as one of the strategically most important economic fields in Latvia and Europe that has a direct impact on the competitiveness and economic growth by creating prerequisites for the development of other fields and attraction of investments by providing substantial income from export services, thus having a positive impact on the national development in general (Latvian National Development Plan for 2021-2027, decision of the Parliament No 418/Lm13, 2.06.2020).

The Cabinet of Ministers order “On the Guidelines for Transport Development 2021-2027” (Order No 710, 21.10.2021.) requires to provide for a coordinated move of transport and logistics export services towards the international market and the inclusion of Latvia into the modern global supply chains. It has been recognized that the importance of new technologies, innovations, digitization, and the role of environmental aspects in the field have been growing, considering the emissions created by the transport industry. The European Green Deal points out the increase of importance of automated and networked multimodal mobility in the future, as well as smart traffic management systems and inter-modular services, which will be provided by the implementation of digitization solutions, therefore the demand for highly qualified specialists, who are familiar with the newest digital technologies, will grow. According to the research carried out in several countries, the estimated increase of vacancies in the field of supply chains will grow by 11% annually until 2027 (e.g., https://www.seek.com.au/career-advice/role/supply-chain-manager). Industry specialists note that currently the priorities in technology are as follows: data analysis, internet of things, cloud computing, and information security (Forbes, GEODIS). Most companies in the field believe that technological advancements have a significant impact on supply chains, logistics and transport operations. However, experts estimate that the global income from specialized LSCM software will reach 8.5 billion USD worldwide by 2022 (Apps Run the World; Statista, 2020).

Graduates of the study programme “Logistics and Supply Chain Management” work in logistics and supply chain companies in Latvia and worldwide: JSC Sonora – Transport and Logistics (Uzbekistan); production companies – Printify (Latvia), Roche (Switzerland), Astra Zeneca (Sweden), Tesla (Germany), NIRx Medical Technologies (Germany). Graduates of the study program also work in IT companies, for example Accenture Latvia, ICONTROL Simulation Solutions (the Netherlands).

Graduates work as logistics assistants, senior procurement consultants, software test engineers, SAP advanced business application programming consultants, software developers, simulation engineers, senior data analysts, supply chain coordination managers, global supply analysts, merchant support senior specialists, warehouse management system specialists and other positions in the fields of logistics and information technology.

Highly-qualified specialists who are able to manage complex processes, implement and maintain appropriate IT solutions for supporting logistics and supply chain management processes are critically important in the field of logistics and supply chain management. Specialists that have acquired the Master’s degree earn 20-25% more than the specialists with basic education (https://www.cv.lv/). Leading specialists also demonstrate a higher employment level. Summarizing the aforementioned, it can be concluded that there is a potential for great long-term and short-term employment opportunities for the graduates of the program, since specialists in the field are vitally important for the development of Latvia and the world.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Students were first admitted to the RTU study programme “Logistics and Supply Chain Management” in academic year 2014/2015. Since then, the number of students in the program grew for several consecutive years and reached 59 in academic year 2018/2019 (Fig. 1). However, it can be observed that the number of students decreased over the next two years, which may be related to the COVID pandemic-caused restrictions, when crossing the borders was made difficult and the interest in studies abroad slightly decreased amongst foreign students.

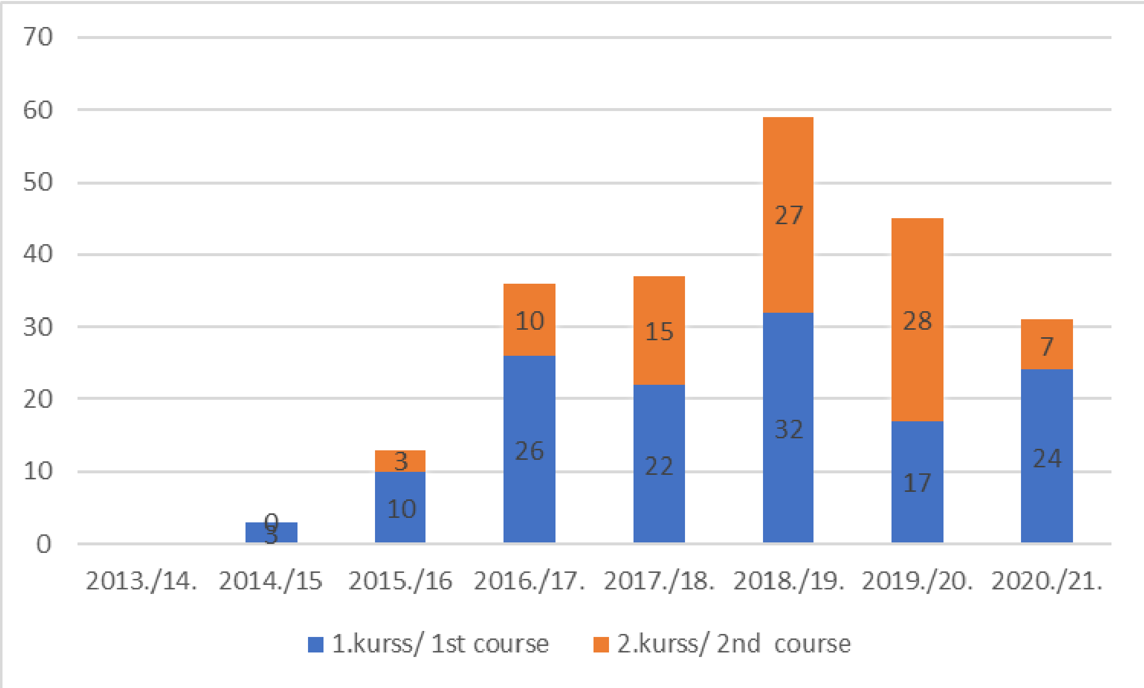


Fig. 1 Student number dynamics during the reporting period.

The number of dropped-out students is not large and amounts to 18% of the first-year students and 20% of the second-year students. Statistical data prove (Annex 5) that the largest number of student drop-outs is observed starting from 2018/19 academic year, which can be partially explained by the consequences of the COVID pandemic and a partial transition to remote studies.

During the reporting period, an increase in the number of graduates is observed, which is related to the increase in the total number of students in the program (Fig. 2).

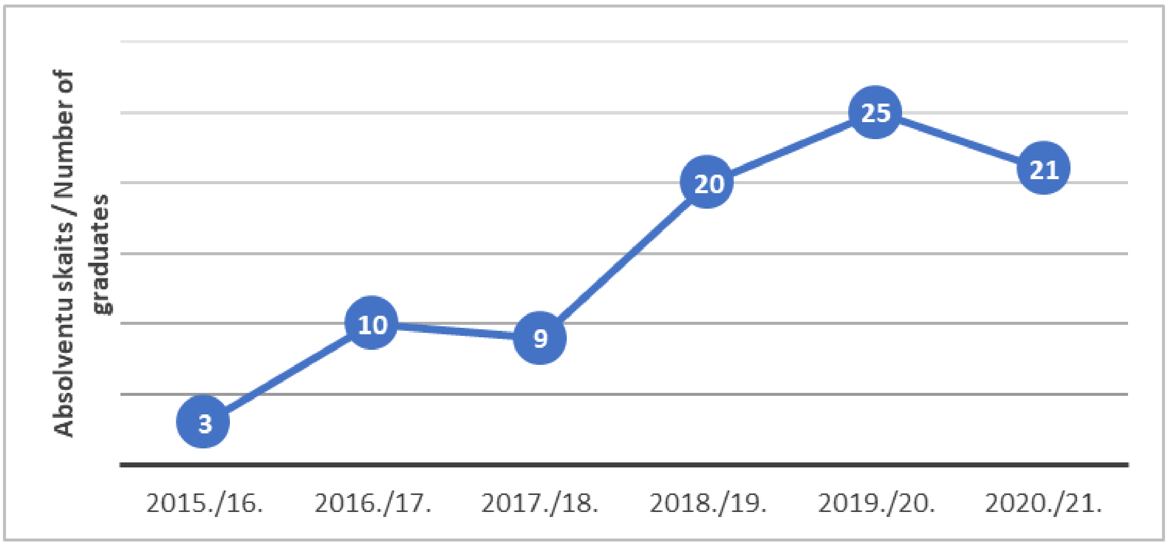


Fig. 2. Dynamics of the number of graduates.

In the framework of the cooperation agreement signed within the study programme, regular student mobility is carried out, namely, students from UAB master 2nd semester courses implemented by RTU. It can be concluded that the number of mobility students has been relatively stable since academic year 2013/14 and on average it amounts to 13-16 students per academic year.

The analysis of student distribution by country of origin shows that most students come from India, however, there are also representatives from other regions of the world, including Europe and Asia. The prevalence of the Indian students is related to the RTU purposeful attraction of students from this country.

Amongst the mobility students, the representation by country of origin is more even, there are more representatives from European, North American, South American countries.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The aims, tasks, curriculum developed for the study programme “Logistics and Supply Chain Management” and methods for its implementation are appropriate for the current industry, technology and sustainability management development trends. All study courses included in the study programme are related to the aims, tasks, and learning outcomes of the study program (the content mapping of the study program is provided in Annex 8). Study course descriptions are available in Annex 10.

The aim of the academic Master study programme “Logistics and Supply Chain Management” is to educate and train highly qualified specialists that understand and are able to implement logistics system technologies, identify, analyze, and solve problems in the field of logistics systems and supply chains related to designing, implementing, operating, and managing logistics systems and supply chains also in the field of information technologies and systems, as well as to develop the student ability to carry out scientific research, take part in local and international projects, continue studies at PhD study programs.

The volume of the academic Master study programme is 80 CP, which consists of compulsory study courses in Part A amounting to 36 CP, compulsory elective study courses in Part B making up 24 CP, and the state examination, namely, the Master Thesis in the volume of 20 CP.

Specialization study courses (Part B, Section B1) form the knowledge base for the application of information technology in the management of logistics systems and supply chains or the technology and implementation of logistics systems. In accordance with the provisions of the cooperation agreement (see the appendix *LSCM_Sadarbibas_ligums_Cooperation_Agreement*), RTU implements a specialization entitled "*Logistics Information Systems*" and UASW implements a specialization entitled "*Logistics Systems Engineering and Implementation*".
The compulsory study courses of the programme offer deeper theoretical knowledge in logistics systems and supply chain management, as well as promote development of research skills necessary for obtaining the academic Master's degree.

Study courses that are included in Part B2 allow students with engineering education to supplement their knowledge in the field of business organization and international economic communication, however, students with education in economics or management can supplement their knowledge of technologies. Course list is shown in Table 1.

Table 1

The list of study courses

No	Code	Title	Credit points
A.		**COMPULSORY STUDY COURSES**	**36 CP**
1.	DMI705	Basics of Logistics and Supply Chain Management	4 CP
2.	DMI714	Modelling and Simulation in Logistics	4CP
3.	DMI715	Optimization Methods in Logistics	2 CP
4.	DMI706	Information Technologies in Logistics	4 CP
5.	DMI749	Management and Information Technologies of Transport Systems	4 CP
6.	DMI704	Supply Chain Network Management Technologies	4 CP
7.	IĀS706	Global Markets and Supply Chains	2 CP
8.	DMI712	LSCM European Dimension	2 CP
9.	DSP737	Systems Thinking	4 CP
10.	DOP711	Project Management	2 CP
11.	IKI761	Quality and Environmental Management	2 CP
12.	IVZ732	Human Resources	2 CP
B		**COMPULSORY ELECTIVE STUDY COURSES**	**24 CP**
B. 1.		**Field-Specific Study Courses**	**20 CP**
	Specialization "Logistics Information Systems"		20KP
1.	DMI708	Logistics Information Systems	6 CP

No	Code	Title	Credit points
2.	DMI707	Electronic Commerce in Logistics	3 CP
3.	DSP738	Systems Analysis	2 CP
4.	DMI716	Decision Synthesis Principles and Practice in Logistics	9 CP
	Specialization “Logistics Systems Engineering and Implementation”		20KP
1.	DMI722	Material Handling System Design and Analysis	6 CP
2.	DMI723	Transport System Design and Analysis	6 CP
3.	DMI720	Logistics Management and Control System Specification and Evaluation	7 CP
4.	DMI721	Logistics System Implementation and Ramp-up	7 CP
B.2.		**Humanities and Social Sciences Study Courses**	**4CP**
1.	IĀS435	Organization and Management of International Economic Relations	2 CP
2.	IĀS701	International Business	2 CP
3.	MAB700	Industrial Engineering	2 CP
4.	DOP712	Information Technology Fundamentals	2 CP
E		**FINAL EXAMINATION**	**20 CP**
1.	DMI726	Master thesis	20 CP
		Total:	**80 CP**

Part E of the study programme “State Examination” focuses on the students’ ability to independently guide own self-development and self-education in the field of logistics system and supply chain management, as well as to conduct scientific research.

In order to meet the legal requirements, in addition to the planned study program volume, foreign students shall master a study course in Latvian for foreign students 1 CP and study courses that ensure the achievement of professional competence in civil defense or environmental protection (VAS038 Environment and climate guide 1 CP and ICA301 Civil protection 1 CP), if the student has not mastered them in a lower level study programme.

The goals and results of the study program are achieved through the realization of study course goals, see Annex 8 "Mapping of study courses" in the appendix, which collects data on the balanced contribution of study courses to the achievement of the results of the study programme.

The updating of the study course content is planned based on industry requirements, labour market and scientific trends. Namely, regularly renewing literature and information sources, inviting guest lecturers from the industry, reviewing and improving course content after consultations with industry experts, incl. in consultation with collaboration partners from academia and industry, e.g. Autonomous University and Technical University of Applied Science Wildau. The course content could be updated based on the conducted research.

Content of the study curses is updated in accordance in with RTU regulations. If significant changes are made to the course content, they are reviewed by the "Information technologies, computer engineering, electronics, telecommunications, computer management and computer science" study field commission, which also includes industry representatives. Operational changes are made by preparing the calendar plan for the current semester in accordance with the RTU regulations "On the use of the RTU e-study system in study subjects". The methodological commission of the FCSIT works to examine current issues. In the faculty seminar for teaching staff, questions about the digitization of the study process, the use of modern study methods, evaluation of study results and academic honesty are considered.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

One of the aims of the study programme "Logistics System and Supply Chain Management" is development of scientific research skills of the students. It is achieved by including information on the newest scientific achievements in the study course curricula, motivating students to implement research within the study courses, involving students in scientific research projects, students also carry out research during the development of their graduation papers. Scientific research is mostly carried out in such fields as electrical engineering, electronics, systems analysis, modeling and design in ICT, as well as logistics and supply chain management.

The most important fields, where students are involved in research:

1. Digitization;
2. Information systems;
3. Information and business management technologies;
4. Modelling and analysis of complex systems.

The study courses integrate the latest findings in the following fields. DMI706 Information Technologies in Logistics and DMI708 Logistics Information Systems research and analyze the use of the newest digital technologies and information systems in supply chains and logistics, DMI712 Regional Development of Logistics Systems and IĀS706 Global Market and Supply Chains view the aspects of the international LSCM business management though digitization, DMI714 Simulation Modelling in Logistics and DMI715 Optimization Methods in Logistics research solving of highly complex tasks adopting approaches of discreet events and continuous system simulation modelling.

International and state research projects are also carried out in following fields:

1. FP 7 ERA-NET (ERA/Net-LAC) project FuturICT 2.0 "Large-scale experiments and simulations of the second generation of future ICT", 01.02.2017. - 9.08.2021.
2. COST action CA19135 connecting education and research communities for an innovative resource aware society (CERCIRAS, 2020-2024)
3. European Innovation Partnership Programme 16.1 project "Innovation solutions for planning and organization of agricultural and forestry products transportation" (2019-2022)
4. Erasmus+ Capacity Building in Higher Education Call EAC/A03/2018 projekta 609557-EPP-1-2019-1-LVEPPKA2-CBHE-JP "Development of practically-oriented student-centred education in the field of modelling of Cyber-Physical Systems" (2019-2022)
5. COST Action IC1404 Multi-Paradigm Modelling for Cyber-Physical Systems (2014-2018)
6. Project of Estonia-Russia Cross Border Cooperation Program

ESTLATRUS/2.1./ELRI-184/2011/14 “Integrated Intelligent Platform for Monitoring the Cross-Border Natural-Technological Systems” ELRI-184, INFROM., 15.02.2012. - 14.02.2014.

In 2019, FCSIT received a rating 4 out of 5 within Scientific Institution International Assessment. The assessment specifically pointed out the contribution to economic development. The high rating confirms the high scientific potential of FCSIT and the academic staff of the study program, and Master studies significantly contribute to promoting this potential. During studies, students develop scientific publications that are also indexed in the international bibliographical data bases:

1. Philip, A., Ginters, E., Basdogan, D. Bayesian Acyclic Network Based Environmental Footprint Risk Assessment System for Oil and Gas Industry. *International Journal of Circuits, Systems and Signal Processing*, 2021, Vol. 15, pp.913-927. ISSN 1998-4464. Available from: doi:10.46300/9106.2021.15.98.
2. Hasanova, H., Romānovs, A. Best Practices of Technology Management for Sustainable Digital Supply Chain. No: *2020 61st International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS 2020): Proceedings*, Latvija, Rīga, 15.-16. oktobris, 2020. Piscataway: IEEE, 2020, 1.-6.lpp. ISBN 978-1-7281-9106-5.
3. Girjatovics, A., Shekar, S., Kuznecova, O., Pečerska, J. Simulation and SCOR: Performance Metrics Integration to Supply Chain Performance Measurement. In: *2019 60th International Scientific Conference on Information Technology and Management Science of Riga Technical University (ITMS 2019): Proceedings*, Latvia, Riga, 10-11 October, 2019. Piscataway: IEEE, 2019, pp.1-6. ISBN 978-1-7281-5710-8.

In order to create a dynamic scientific environment, the Institute of Information Technology publishes a collection of articles “Information Technology and Management Science”, organizes the annual international scientific conference “IEEE Information Technology and Management Science Conference” (http://itms.rtu.lv/), the seminar of the institute and a section in the students’ conference. Master students actively participate in all these events.

Active involvement of the academic staff and students of the study program in research projects and contracted works in the industry attests the significance of Master level studies. For example, they participated in implementation of such important projects:

- FP 7 ERA-NET (ERA/Net-LAC) project FuturICT 2.0 “Large-scale experiments and simulations of the second generation of future ICT” (2017-2021);
- Development of a prototype of a multimodal mobility planning and effective evaluation tool. Voucher project LV8966, contract on the implementation of the experimental development No JS 8/2021i with "Map Publishing house Jāņa sēta".

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study programme “Logistics and Supply Chain Management” is carried out in English and is implemented in the form of full-time intramural studies. Implementing the program curriculum, all provisions of the regulatory enactments are considered, basic principles of organizing the study process determined by RTU and all study course requirements are met. Study course descriptions present information on the relevant knowledge, skills and competences and their assessment system, define the expected learning outcomes that provide ground for granting credit points. Assessment of the student knowledge, skills and competences is regulated by the decision of RTU Senate of 27 May, 2017, “On Regulation on the Assessment of Learning Outcomes”, which comply with the basic principles and processes of education assessment within the relevant study cycle defined by the by-laws issued by the Cabinet of Ministers. The summative assessment system, where the final grade consists of several components, is used to assess student achievements. Full-time studies correspond to the volume of 40 CP during an academic year, and 1 CP translates into 40 academic hour load during a single week of studies. At the Master level, 40% of the study load is made up by contact hours and 60% - by independent work.

The pedagogical methods for delivery of the study courses are selected by the responsible instructors considering the specifics of the study program and student needs. Lectures are often carried out in a study room, however the practical classes - in small groups, in the computer room. In academic matters, individual approach is provided according to the methodology approved by the order of RTU Rector “On Work Planning Guidelines for the Academic Staff”, where it is specified that the academic staff shall ensure tutorials per every 25 students in the lecture flow amounting to 15% from the total lecture hours. Additional separate tutorial hours are designated for managing term papers and projects, as well as graduation papers. Pre-examination tutorials are organized before examinations. If necessary, students may contact the academic staff directly outside tutorials by sending the relevant questions as messages or in the study course forum in the ORTUS system or ask these questions via e-mail.

The basic principles for ensuring the internal quality of the study programme are:

- Instructor responsible for the study course is responsible for achieving specific study aims and completing the tasks of the study course,
- The responsible organizational unit controls the activity of the academic staff involved in the study process,
- The planning and management of the study program is carried out by the head of the study program,
- Methodological activities are realized via methodological seminars at the organizational unit,
- Overall, the learning outcomes are evaluated and changes in the study program are initiated by the council of FCSIT Institute of Information Technologies,
- Students also evaluate the realization of study courses by filling out surveys at the end of each semester; survey results are evaluated by the appropriate academic staff and the head of the study program and make decisions on introducing changes in the study course delivery process, if necessary.

The didactical concept of the study program is realized through the application of progressive study methods. It envisages implementation of the study process that ensures successive and in-depth acquisition of the knowledge provided within the study program. Thus, in the 1st year, students master the compulsory study courses from Part A and elective courses from Part B1. In the 2nd year, they continue to master the compulsory study courses from Part A and improve their knowledge within compulsory elective courses from Part B, and also freely selected elective courses (Part C) and select the topic of their Master Thesis, the development of which is allocated for the spring semester of the 2nd year. In addition to the study courses included in the program, foreign students master the study course VSL711 the Latvian Language amounting to 1 CP within Part C.

The framework of each study course describes its assessment system that represents all types of tests that must be completed by the student. When developing the assessment criteria within the study programme, the following basic principles have been considered:

- the principle of summarizing positive achievement;
- the principle of compulsory assessment;
- the principle of dependency and compatibility of assessment criteria;
- the principle of assessment form diversity;
- the principle of accessibility of testing.

In addition to the theoretical lectures in auditoriums, practical learning trips to the largest companies in the industry are organized for the students (for example, DB Schenker, HAVI Logistics, Baltic Container Terminal, Riga Port, etc.). In such a way the programme ensures integration of industry specifics into the curriculum of the study programme.

Student subject knowledge is assessed following Cabinet Regulations No 2 of 3 January 2002 "Regulations on the Standard of State Academic Education" and the respective decision of the RTU Senate (RTU Regulation on the Assessment of Learning Outcomes of 29 May, 2010, Minutes No 539). In order to ensure the summary of students' grades across all partner universities involved in the implementation of the programme, the acquired grades are converted in the unified ECTS grading system in accordance with the terms defined in the annex to the cooperation agreement.

It is allowed to present the Master Theses if students' knowledge and skills have been assessed as successful in all study courses of the study programme. At RTU, defence of the Master Theses is organized in accordance with the procedure adopted by RTU, allowing the opportunity for representatives from partner universities to take part in the examination committee (on-site or remotely).

Assessment criteria of the education to be obtained are based on the learning outcomes of the study programme and the study courses. They are used in assessment of the quality of student's practical works, lab works, study works, independent work, as well as other activities, examinations and the Master Thesis. Specific assessment criteria within each course are defined by the responsible instructor. Students are informed about the assessment criteria at the beginning of the semester; they are accessible electronically in ORTUS e-learning environment.

RTU e-learning platform ORTUS (www.ortus.lv) is used in the implementation of the study programme. ORTUS provides access to all relevant information in the study process - study course materials, information on student's performance, topical announcements, access to the e-resources of the RTU Scientific Library, e-mail, etc. The faculty can set up different exercises and tests for evaluation and self-evaluation of knowledge in the e-learning environment.

The most important aspects of the student-centered approach are described below.

1. Involvement of students in the study process and updating of the curriculum

According to RTU procedures, students can regularly give feedback about the curriculum. Students at the programme are regularly involved in assessment of the study programme quality and take part in decision-making bodies and advisory bodies (the Faculty Council, the Methodological Committee, the Study Field Committee). In addition to formal processes, students regularly meet with the Programme Director, when the content and quality of studies is discussed. Mid-term and semestral surveys are organized to let students give feedback about the study courses. Furthermore, at any time students can apply to the Programme Director or RTU Study Department with an option to complain anonymously, in order to let them know about problems arising during the studies. Graduates of the study programme fill in the form about the studies in general.

2. Learning outcomes

At the study courses, the academic staff clearly define the learning outcomes to be acquired, as well as connect the results with the study programme outcomes and credit points of the course. The academic staff take into account diversity of students, offering tasks of different complexity, as well as offering learning materials for the acquisition of both the basics of a study course and the in-depth knowledge of the curriculum of a study course. Students also are offered a vast variety of educational materials (documents, presentations, video recordings, interactive educational materials, etc.).

3. Mobility

RTU offers a wide variety of opportunities to participate in international mobility: 1) Erasmus+ programme; 2) Nordtek and Baltech programmes; 3) specialized cooperation programmes and 4) financing of projects. In the framework of exchange programs, RTU provides students with an opportunity to study voluntarily at some foreign university for some period of their studies (normally, one academic term, but other mobility duration options also are possible), gaining a foreign IT education experience. Furthermore, RTU regularly takes up opportunities of attracting visiting researchers, who share their experience with students through individual guest lectures or the whole study course. Also, when meeting visiting professors at specially organized workshops, the academic staff involved in the programme can adopt good practices, which visiting professors share. Mobility opportunities also are the means for advancement of academic staff qualification, wherein they gain experience at foreign universities. More detailed information about the attracted guest professors and mobility of the academic staff is given in Part 3.4.1. “Compliance of the qualification of the involved academic staff”.

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs. Students take up employment early. Online attendance opportunities help students reconcile studies and work.

5. Teaching and learning methods

Within the programme, various teaching and learning methods mentioned above are implemented, they are adapted by the academic staff to each particular situation (see the description at the beginning of the section). Students can attend individual consultations, including communication in the e-environment using RTU licenses on Zoom and MS Teams platforms, as well as Moodle instant message services.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Embarkment. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classes. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools).

In the process of programme implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.).

7. Development of the academic staff competences

The academic staff involved in the implementation of the programme is provided with opportunities to improve their methodological and didactic skills on a regular basis. The process of academic staff competence development includes methodological seminars organized by the Institute of Information Technology and FCSIT on the application of teaching and learning methods, including innovative learning methods, as well as methodological conference organized by RTU and LSCM consortium.

8. Extracurricular student activities offered by the Institute of Information Technology, RTU International Cooperation and Foreign Students Department and student self-government - students are involved in scientific activity and research on the issues topical for the industry. The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results. Students at the program are offered a vast variety of extracurricular activities (sport teams, dance groups, choirs, etc.)

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Students develop their Master Theses during the spring semester of the 2nd study year. Each year, the information on topical thesis themes received from academic staff is summarized and offered to students.

During the reporting period, 88 Master Theses have been presented in total with the average grade of 6.9. More detailed distribution of final grades is shown in the histogram (Fig. 3).

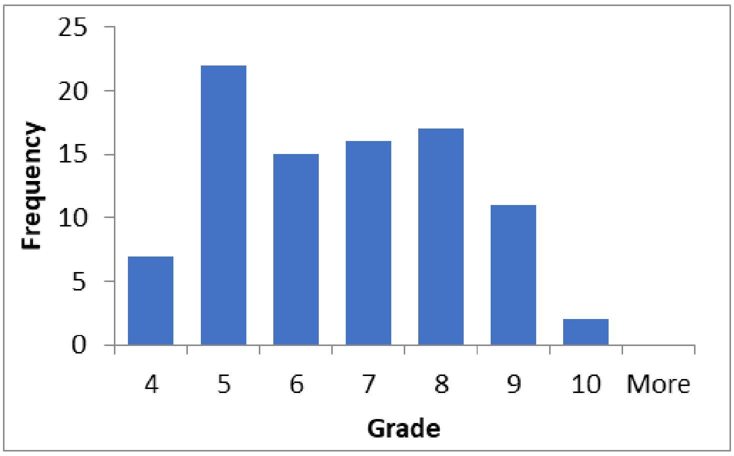


Fig. 3 Histogram of the frequency of final grades.

Amongst the works developed within the framework of the study programme there are both scientifically oriented works and works developed in collaboration with a company. Examples of the themes of Master Thesis grouped by research fields can be found below (Table 2).

Table 2

Sample Master Theses Themes

Research area	Theme of the Master Thesis
Cooperation with an enterprise	SCOR Based Analysis of Warehouse Processes for a Distribution Centre
Impact of COVID on logistics and supply chain	Cold Chain Logistics for Covid-19 Vaccine
	Role of Artificial Intelligence In Warehouse Management in Current And Post Covid Era
Green logistics	Green Supply Chain Sustainability
	Environmental Footprint of Supply Chain in Oil and Gas Industry
	Development of an Approach to Reduce the CO2 Emission in Logistics
Optimization of logistics systems	Optimization of Automated Guided Vehicles Flow Path in Smart Warehouse
	Operational Planning Optimization in Delivery Logistics
Warehouse automation	Optimization of Automated Guided Vehicles Flow Path in Smart Warehouse
	Development of Automation Solutions in Warehousing
	Analysis of Automated Storage and Retrieval Systems Development Trends in Warehouse Management
Transport logistics	Analysis of Transportation Methods for Grocery Home Delivery
	The Application of Automated Transportation in Logistics
Simulation	Simulation-based Distribution Centre Capacity Analysis
	Discrete Event Simulation for Warehouse Systems Analysis
	Conceptual Modelling for Simulation–based Analysis of the Order Picking Processes

Research area	Theme of the Master Thesis
IoT in logistics	IoT Applications for Smart Logistics Services
	Development of an Automated Approach to Smart Warehouse Management in Supply Chain Network Using IoT
	Application and Impact of IoT in Logistics Industry

Numerous students of the programme developed their graduation papers in foreign universities in the framework of student exchange program ERASMUS+. For example, the thesis “Analysis of Yard Operations in the Haven Genk Terminal Towards Lean Logistics” was developed by a student in Hasselt University, Belgium, whereas the theses “Cloud Optimization Services in Logistics” and “Applying Big Data Analytics to Increase Supply Chain Performance” were developed by students in Leoben University in Austria.

In order to strengthen international cooperation, academic staff from Old Dominion University in the USA were involved in supervising students’ graduation papers. In the framework of this cooperation, the work “Urban Freight Transportation Demand Model Analysis and Application” was developed.

Students carry out research in different fields, including those that are especially relevant nowadays, for example, the effects of COVID pandemic on logistics systems and supply chains, green logistics and use of the internet of things, as well as in the fields that are historically related to logistics and supply chain problem solving, for example, simulation, optimization, system automation, etc.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- RTU Faculty of Computer Science and Information Technology
- RTU Faculty of Engineering Economics and Management
- RTU Faculty of Mechanical Engineering, Transport and Aeronautics

Riga Technical University provides the study program with a corresponding learning environment. It comprises:

- lecture halls and classrooms,
- laboratory equipment,
- e-learning environment,
- bibliographic and other resources.

For each study course, the study base and resources necessary for it are indicated, which ensure the achievement of the results of the study program through the realization of the goals of the study courses.

The studies take place mainly at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at 10 Zunda krastmala, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The conference center has a large auditorium with 500 seats, the faculty has 12 auditoriums with 25-200 seats and 10 computer classrooms with 20-25 workplaces. Students can use their laptops and connect to RTU Wi-Fi networks. The lecture halls are equipped with modern audio and video equipment, including a digital projector, a computer, a remote control, audio devices, microphones and cameras. The faculty is located in the same campus as RTU Scientific Library, which provides rooms for group work and quiet reading rooms.

Software appropriate for the needs of study program and relevant trends is used in the study process:

- Specialized logistics system and supply chain environments that ensure implementation of active learning approach: the Fresh Connection, International Management Game, ECLIPS, BeerGame.
- Traffic system simulation modelling tool Aimsun, which offers a comprehensive solution portfolio for adaptive traffic control and management, automation of highways and tunnels.
- Geographical information system (GIS) software ArcGIS, which allows processing and analyzing the geographical and spatial information by visualizing geographical statistics using layer-forming maps, for example, product delivery or trading flow.
- Specialized simulation software systems ARENA, Simul8, MATLAB that are used by students to develop and use complex logistics and supply chain management task simulation models.

The overall detailed description of the infrastructure and material-technical base of the study course, as well as the methodological and informational provision, is given in the description of the course, part II, chapter 3 "Resources and provision of the study course", where subsection 2.3.2 is devoted to the description of the infrastructure and material-technical provision, while 2.3. 3 provides a detailed description of the methodological and information provision (including the range of options offered by the RTU Scientific Library (SC)).

RTU Scientific Library (SC) is a library of national importance, which provides RTU study process and research activities with the necessary information, provides librarian, bibliographic and informational services for RTU students, teaching staff, and employees. SL has 1.3 million printed documents and e-resources in databases corresponding to RTU branches. Stock replenishment takes place according to the recommendations of study program managers and researchers, considering the allocated RTU funding.

SL information sources are located in the open access collection. Books and periodicals according to RTU study directions are located in ZB Central Building at P. Valdena street 5 according to UDC indexes. They are always available to users. Publications not available at SL are delivered via Interlibrary Loan or International Loan. Internet access is provided throughout SL.

RTU subscribes to internationally recognized electronic databases with the help of EIFL (Electronic information for Libraries, http://www.eifl.net/). Teaching staff is adviced to recommend to students one of the e-books available in the bibliographic resources at SL. To deepen knowledge in the subject of the study courses and to conduct appropriate research, Logistics and Supply Chain

Management study program students widely use electronic resources, such as ScienceDirect, SCOPUS, Web of Science, IEEEXplore, ProQuest Ebook Central, EBSCOhost, Wiley Online Library, SpringerLink, as well as Latvian databases (LETA, Letonika, Latvian standards database).

pen access collection. Books and periodicals according to RTU study directions are located in ZB Central Building at P. Valdena street 5 according to UDC indexes. They are always available to users. Publications not available at SL are delivered via Interlibrary Loan or International Loan. Internet access is provided throughout SL.

RTU subscribes to internationally recognized electronic databases with the help of EIFL (Electronic information for Libraries, http://www.eifl.net/). Teaching staff is adviced to recommend to students one of the e-books available in the bibliographic resources at SL. To deepen knowledge in the subject of the study courses and to conduct appropriate research, Logistics and Supplu Chain Management study program students widely use electronic resources, such as ScienceDirect, SCOPUS, Web of Science, IEEEXplore, ProQuest Ebook Central, EBSCOhost, Wiley Online Library, SpringerLink, as well as Latvian databases (LETA, Letonika, Latvian standards database).

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The data on study programme funding are presented in Table 3

Table 3

Information on the Study Programme Funding

Academic year	State subsidy, EUR	Tuition fees at the programme, EUR		Total study programme funding, EUR	Funding of one state budget funded seat, EUR
		Local student tuition fees, EUR	Foreign student tuition fees, EUR		
2014/2015	-	-	-	-	-
2015/2016	-	1.200.00	1.653.64	2.853.64	-
2016/2017	-	-	85.915.75	85.915.75	-
2017/2018	-	-	96.749.34	96.749.34	-

2018/2019	-	-	138.224.28	138.224.28	-
2019/2020	-	3.325.00	143.964.70	147.289.70	-
2020/2021	-	3.325.00	107.442.44	110.767.44	-

Study program costs per student for the study year 2021/22, as well as the distribution between cost items, are summarized in the table:

	Foreign students	
Cost Item	***Total EUR***	***%***
Average actual costs per 1 student	2952,25	100%
Remuneration	1543,63	52%
Employer's SSIC, compensations and benefits	376,46	13%
Business trip expenses	0,14	0%
Payments for services	687,04	23%
Materials, energy resources, inventory	7,39	0%
Purchase of books and magazines	63,4	2%
Purchase and modernization of equipment	4,54	0%
Administration costs	206,05	7%
Infrastructure costs	47,71	2%
Social security costs	15,85	1%

Information on the breakdown of funding between cost items is provided in the Annex "*Breakdown of funding between cost items*" of the Self-Assessment Report.

Information on the minimum number of students required for the study programme is given in the Annex to the Self-Assessment Report "*Minimum number of students to ensure the cost-effectiveness of the study program*".

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study programme comply with the guidelines for the implementation of the study programme and the requirements of the regulatory enactments, which ensures achievement of the aims and learning outcomes of the study programme and the corresponding study courses (see CVs of the academic staff). In total, 28 members of academic staff are involved in the implementation of the study programme, 24 hold a PhD. The composition of academic staff by positions is presented in Fig. 4.

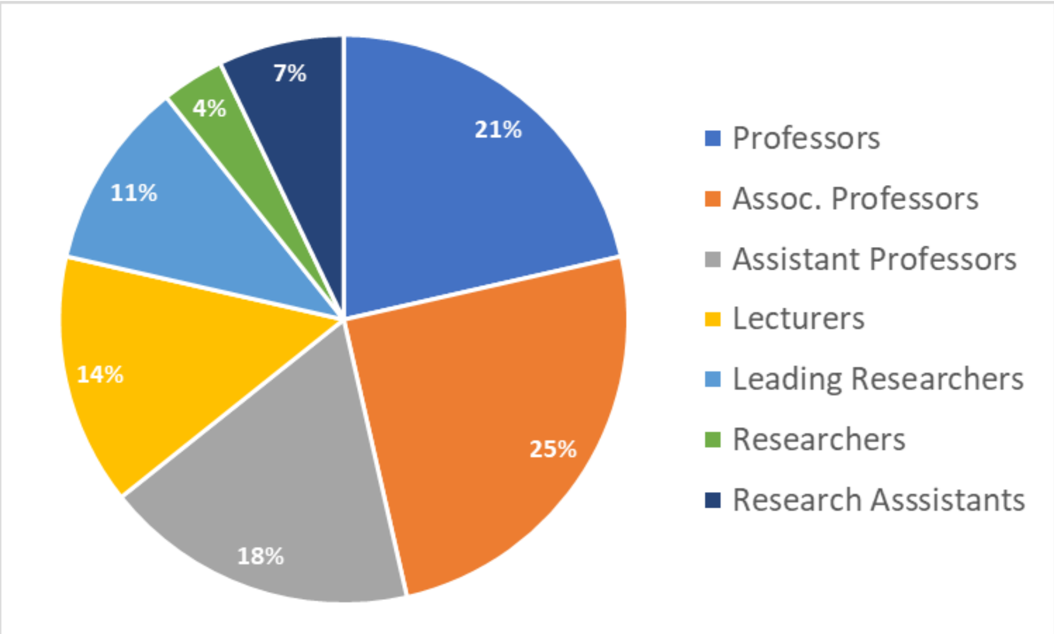


Fig. 4. Composition of academic staff by positions.

To ensure the quality of study curriculum, academic staff involved in programme implementation regularly advance their professional and academic knowledge participating in methodological seminars, conferences and research projects (more detailed information is available in faculty CVs).

The following staff are responsible for implementation of the study courses:

- **RTU Faculty of Computer Science and Information Technology** professors J. Grabis, J. Merkurjevs, E. Ginters, G. Merkurjeva, associate professors A, Romānovs, A. Lektauers, J. Pečerska and J. Kampars.
- **RTU Faculty of Engineering Economics and Management** professors E. Gaile-Sarkane and R. Počs, associate professor D. Solovjovs, leading researcher J. Mazais and assistant

professor O. Bogdanova;

- **RTU Faculty of Mechanical Engineering, Transport and Aeronautics** associate professor A. Kromanis.

All instructors responsible for the study courses hold a PhD in the corresponding field.

Information on the leading members of academic staff involved in the implementation of the study programme is provided below.

Assoc. prof. Andrejs Romānovs – Dr.sc.ing., associate professor and leading researcher at RTU Institute of Information Technology, Head of the Department of Modelling and Simulation, Head of RTU Master study programs “Logistics and Supply Chain Management” and “Cybersecurity Engineering”. 20 years of pedagogical experience in delivery of numerous study courses at Riga Technical University and more than 30 years of professional experience in IT. Co-author for more than 100 international scientific publications in the fields of information technology modelling, cybersecurity, logistics and supply chain management, 58 of which are indexed in Scopus data base (Scopus h-index is 9). Organized more than 30 international scientific conferences and took part in implementation of several scientific research projects in Latvia and internationally. A member of councils and associations in several fields: LCS expert in the field of Information Technology, member of RTU FCSIT Council, member of RTU ITI Council, member of the Latvian Society for Modelling and Simulation, senior member of the Institute of Electrical and Electronics Engineers (IEEE), member of Information Systems Audit and Control Association (ISACA); member of academic networks – IBM Academic Initiative, SimFlex for Academics, Palo Alto Networks, Pearson Higher Education Network, Check Point Secure Academy.

Prof. Jānis Grabis – Head of the Institute of Information Technology of RTU Faculty of Computer Science and Information Technology. A co-author of over 125 “Scopus” indexed international scientific publications about the issues related to enterprise integration, optimization and digitalization of project management and business processes (“Scopus” h-index is 12). Prof. Grabis worked as a researcher or a visiting professor at the University of Michigan-Dearborn and Stockholm University; has led and participated in more than 12 scientific research projects, including EC framework programs, ERDF practice-oriented research, LCS (Latvian Council of Science) Fundamental and Applied Research Program, projects of EEA and Norway grant and State Research Program, as well as in more than 10 contracted works in cooperation with the companies. Head of the Bachelor, Master and PhD study programs in Information Technology. In 2021 was recognized as RTU Academic Staff of the Year.

Dr.oec., Professor Elīna Gaile-Sarkane - more than 20 years of academic and research experience at higher education institutions. E. Gaile-Sarkane has authored more than 150 scientific publications in management, economics and related areas, more than 35 of these publications are published in internationally recognized journals or conference proceedings indexed in international databases (e.g., Thomson and Reuter, Scopus, EBSCO, etc.). E. Gaile-Sarkane is the author and/or co-author of 4 resource books, 3 monographs, 1 patent. 4 PhD in economics have been obtained under her supervision. Prof. Elīna Gaile-Sarkane is a member of RTU Doctoral Board P-09, expert of LCS, expert of the Czech Grant Agency, member of many international organizations, member of the Joint Professorial Council of Riga School of International Economics and Business Administration, School of Banking and Ventspils University College in the field of Management and Economics. Prof. Elīna Gaile-Sarkane actively participates in organizing international scientific conferences. In the last 6 years, she participated in implementation of 7 international projects as an expert, researcher or project manager (more than 20 projects since 2001), promoting interdisciplinary, international cooperation making a significant contribution to improvement of the Latvian education system.

Prof. Jurijs Merkurjevs (Yuri Merkuryev in English) is Full Professor and Senior Researcher at the

Department of Modelling and Simulation of the Institute of Information Technology at Riga Technical University, Latvia. He holds Dr.sc.ing. (1984, in Systems Identification) and Dr.habil.sc.ing. (1997, in Modelling and Simulation) degrees, both from Riga Technical University. His professional interests include modelling and simulation of complex systems, methodology and practical application of discrete-event simulation, supply chain simulation and management, as well as education in the areas of M&S and logistics management. Prof. Merkurjevs is regularly involved in performing research projects in the area of simulation-based sustainable management of complex systems, at both international and national levels. In the academic field, his teaching experience includes courses in discrete-event systems simulation (both introductory and advanced) and supply chain management, he also performed the duties of the head of the international RTU Master study programme "Logistics and Supply Chain Management" (2012-2020). He has delivered guest lectures and courses at many universities in Europe, Asia and North America, and supervised 10 PhD Theses that resulted in students obtaining a doctorate. Prof. Merkurjevs is a full member of the Latvian Academy of Sciences, Latvian State Emeritus Scientist, President of Latvian Simulation Society, Fellow of the European Academy for Industrial Management, senior member of the Society for Modeling and Simulation International (SCS), senior member of the Institute of Electrical and Electronics Engineers (IEEE), as well as a member of the International Simulation Team Excellence Network in M&S. He is an associate editor of "Simulation: Transactions of The Society for Modeling and Simulation International", and a member of editorial board of "International Journal of Simulation and Process Modeling". Prof. Merkurjevs has authored more than 370 scientific publications, including 52 journal papers, 15 book chapters and 11 books, as well as published 7 text books. He is regularly involved in organization of international scientific conferences in the area of modelling and simulation. In particular, he is serving as a General Co-Chair of the annual International Multidisciplinary Modeling & Simulation Multiconference (I3M), and General Co-Chair of the annual International Conference "Harbour, Maritime, & Multimodal Logistics Modelling and Simulation" (HMS).

Prof. Egils Ginters, Dr.sc.ing. (1996), professor and leading researcher (2016) of the Faculty of Computer Science and Information Technology of Riga Technical University, corresponding member of the Latvian Academy of Sciences (2017), full member of the European Academy for Industrial Management (2019), member of the board for several IT companies (1991). Senior member of the Institute of Electrical and Electronics Engineers (IEEE), as well as the Vice- President of the Latvian Society for Modelling and Simulation and a member of the European Society for Social Simulation. Fields of scientific research: Modelling of socio-technical and distributed systems and simulation modelling, use of virtual and augmented reality technologies in restoring human resources communication and working abilities, use of digital technologies in logistics information systems. Simultaneous research result validation in private companies is a characteristic feature of research conducted by Prof. Ginters. Significant international scientific research projects: FLAG-ERA FP7/H2020 FuturICT 2.0 (2017-2021), FP7-ICT-2011-7 FUPOL No. 287119 (2011-2015), FP7-ICT-2009-5 CHOREOS No. 257178 (2010-2014), FP6-IST-2002-2.3.2.6 e-LOGMAR-M No.511285 (2004-2006), LdV SocSimNet LV/B/F/PP-172.000 (2004-2006), LdV LOGIS MOBILE LV/B/F/PP-172.001 (2004-2006), FP5-IST BALTPORTS-IT (2000-2003), LdV LOGIS LV-PP-138.003 (2000-2002), EC INCO Copernicus DAMAC-HP PL976012 (1998-2000), EC INCO Copernicus AMCAI 0312 (1994-1997). Published works: Hirsch index – 12; ORCID ID: 0000-0003-2394-6109, scientific articles that have been indexed in SCOPUS ID: 6506734286 - 81, more than 190 scientific publications, 2 patents. Editor of the journal Mathematics (ISSN 2227-7390, MDPI, Q1 cohort) (2021). Reviewer for the journals: Resources, Conservation & Recycling (2020), Energy for Sustainable Development (2020), Journal of Advanced Research (2020), Cities (2018), Technologies (ISSN 2227-7080) (2018), Heliyon (2017, 2018), Symmetry (ISSN 2073-8994) (2017), Journal of Renewable and Sustainable Energy (2017, 2020), Journal of Mathematics, Science and Technology Education (ISSN 1305-8223) (2016, 2017), Information Sciences (ISSN 0020-0255) (2015, 2016, 2018), Computer & Education (2015, 2016), Computational and Mathematical Organization Theory (ISSN 1572-9346) (2015), Mathematical Problems in Engineering (ISSN 1563-5147) (2015) and others. EC H2020 Framework program expert (2020-2021). Pedagogical work: supervised more than 40 Master Theses and 2 PhD Theses that resulted in obtaining a doctorate.

Prof., Dr.habil.sc.ing. Gaļina Merkurjeva has been working at RTU since 1974. From 2002 to 2021, she was a professor at the Department of Modeling and Simulation of the Institute of Information Technology. In 2004, she was awarded the title of RTU Professor, and in 2019 - the title of RTU Professor Emeritus. She was an Honorary Visiting Professor at the University of Ljubljana (2005-2010, Slovenia), underwent internship at Åbo Akademi University, DataCity Research Center (10 months, Turku, Finland). She published 205 scientific publications, including 7 books and more than 20 scientific articles in internationally recognized journals, including Fuzzy Sets & Systems, the European Journal of Operational Research, Simulation, the International Journal of Computational Science (Scopus h-index is 11, and Web of Science h-index is 9). Prof. Merkurjeva managed and participated in more than 25 research projects, including 17 international research projects. In 2014, results of her research were included in the list of the most significant achievements of the Latvian science named by the LAS. In 2017, she was awarded the title of RTU Honorary Employee. In 2021, she was awarded the title of State Scientist Emeritus was awarded.

Assoc. Prof. Jeļeļena Pečerska - an educator at RTU FCSIT Department of Modelling and Simulation. Co-author of 13 international scientific publications indexed on Scopus data base on the theoretical aspects of simulation, use of Montecarlo methods, business process digitization, intellectual process analysis matters (Scopus h-index 2). Took part in 4 international scientific research projects, academic conference organization committees, supervised Bachelor and Master theses in information technology.

Assoc. prof. Arnis Lektauers, Dr.sc.ing. – Associate Professor and Leading Researcher at the Department of Modeling and Simulation of RTU FSCIT Institute of Information Technology. A co-author of more than 45 international scientific publications on high-performance interactive computer simulation solutions for complex systems. Participated in more than 10 scientific research projects, including EC Framework Program, EEA and Norwegian grants, State Research Program projects, as well as implemented more than 5 contracted works in cooperation with the enterprises. Along with academic and scientific experience, he has 26 years of professional experience in local and international IT companies. He has been a member of the Modeling and Simulation Group of the NATO Science and Technology Organization since 2011.

Assoc. prof. Jānis Kampars – Member of the Board of the Latvian Open Technology Association, Latvian representative in the group of independent experts of the EC *Destination Earth* initiative. A co-author of more than 30 international scientific publications on cloud computing, horizontally scalable real-time data processing systems, digital transformation indexed in Scopus database (Scopus h-index is 6). Actively cooperates with the Latvian Association of Local and Regional Governments, Riga Planning Region, Riga and Kuldiga Municipalities, the Ministry of Environmental Protection and Regional Development, Latvian State Roads, Latvian Road Maintenance Authority and Latvian companies in the issues of digital transformation, open source and open data promotion, use of digital twins. Assoc. prof. Kampars uses the established cooperation network to enhance the study process. Participated in the implementation of more than 9 research projects.

Prof. Dr.sc.ing. Jānis Mazais. Apart from his academic, scientific and organizational work, J. Mazais is actively involved in the Latvian and world organizations, promoting implementation and development of quality standards. He is the Chairman of the Accreditation Commission of the Latvian National Accreditation Bureau, STK Vice-Chairman in the technical committee of the Latvian

Standards LVS/STK/10 “Quality Management and Qualiti Assurance”. RTU representative in the Latvian Quality Society, member or the American Society for Quality (since 1992). Is the author or co-author of more than 40 scientific publications.

The database of experts of the Latvian Council of Science (LCS) includes nine academic staff members (Table 4) that are active in the fields of engineering and technology - Electrical Engineering, Electronics, Information and Communication Technology or Mechanical Engineering and Mechanics; Natural Sciences - Computer Sciences and Informatics in the field; Social Sciences - Economics and Entrepreneurship, Political Science, Education Sciences or other social sciences including interdisciplinary social sciences and military science.

Table 4

Academic staff with LCS expert status

Name	**Surname**	**ORCID**	**Scientific field(s)**	**Election term**
Jurijs	Merkurjevs	0000-0001-7178-5640	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Egils	Ginters	0000-0003-2394-6109	Engineering and technology - Electrical engineering, electronics, information and communication technology	31.03.2024
Jānis	Grabis	0000-0003-2196-0214	Engineering and technology - Electrical engineering, electronics, information and communication technology	05.01.2025
Andrejs	Romānovs	0000-0003-1645-2741	Natural sciences - Computer science and informatics	25.05.2023
Jānis	Kampars	0000-0003-0045-5593	Natural sciences - Computer science and informatics	04.11.2023
Elīna	Gaile-Sarkane	0000-0002-7509-5273	Social sciences - Economics an entrepreneurship, Political science	18.11.2022
Remigijs	Počs		Social sciences - Economics an entrepreneurship	18.12.2022
Inga	Lapiņa	0000-0003-3019-2472	Social sciences - Political science	05.05.2024
			Social sciences - Economics an entrepreneurship	31.03.2024
			Social sciences - Other social sciences, including interdisciplinary social sciences and military science	22.01.2023
Artis	Kromanis	0000-0002-0244-0451	Engineering and technology - Mechanical Engineering and mechanics	18.09.2022

Guest lectures are carried out regularly in the framework of the study programme, they are delivered by both representatives of the foreign universities and local industry representatives. The total amount of guest lectures is 250 academic hours (Table 5).

Table 5

List of Guest Lectures

Course	Guest lecture topic	Lecturer	Academic hours	Date
Decision Synthesis Principles and Practice in Logistic	Logistics as Part of Business Services Industry	Vladislava Tiskina, Sales manager, Containerships as part of CMA CGM Group, (Latvia)	2	30.11.2020
	On-line real-time supply chain management with 'Universal Exports'	Prof., Dr. Jan Riezebos, University of Groningen (Holland)	48	October 2019
	Intensive Course in 'LEAN BASICS'	Prof., Dr. Rik Van Landeghem, University of Ghent (Belgium)	16	October 2018
Electronic commerce in logistics	Technology Capabilities - How We Can Use Them and Build on Them. Business Process Automation	Andris Petersons, Strategic Business Analyst, SEB Global Services (Latvia)	2	01.12.2020
	Consolidated Procurement and Delivery of It Equipment Worldwide	Sergejs Anzinovskis, Senior Global Solution & Operational Manager, Atea Global Services (Latvia)	2	08.12.2020
Logistics information systems	Transport Model Management Using Simulation approach	Dr. Nadežda Zeņina, leading engieener, SIA Śolvers (Latvia)	2	10.05.2016.
	How To Be a Global Player with The Help of a Worldwide Supply Chain?	Pauls Jansons, Global Delivery Operations Manager, Atea Global Services (Latvia)	2	15.12.2020
LSCM European Dimension	LSCM activities in Germany	Prof. Gaby Neumann, TH Wildau (Germany)	2 (16)	annual event since 2014
	LSCM activities in Spain	Prof. Dr. Juan José Ramos Prof. Gaby Neumann, TH Wildau (Germany) González, Autonomous University of Barcelona (Spain)	2 (16)	annual event since 2014
	Global Sourcing and Intercultural Negotiations	Wouter Faes, Hasselt University (Belgium)	2 (16)	annual event since 2014
	LSCM activities in Belgium	Prof. Dr. Gerrit Janssens Hasselt University (Belgium)	2 (6)	09.04.2015, 14.04. 2016, 20.04.2017
	LSCM activities in Ausria	Prof. Dr. Helmut E. Zsifkovits, Montanuniversität Leoben (Austria)	2 (8)	Annual event 2014 - 2017
	LSCM activities in Latvia	Dr.sc.ing. Olga Girvica, Managing Director, SIA MYECO (Latvia)	6 (18)	Annual event 2014 - 2016
Management and Information Technologies of Transport Systems	Performance Calculations in Intralogistics	Prof. Gaby Neumann, TH Wildau (Germany)	12 (96)	annual event since 2014

ERASMUS+ programme is important for improving qualification. For example, assoc. prof. A. Romānovs took part in academic exchange programs in Autonomous University of Barcelona, Spain (2014-2021), Vilnius Gediminas Technical University, Lithuania (2019), Chennai Vel Tch University, India (2018).

The highest qualification of academic staff is also attested by their work at the universities abroad. For example, Jānis Grabis was a guest professor at the University of Stockholm and an expert at the University of Rostock. Prof. Merkurjevs has delivered guest lectures in:

- Hasselt University, Belgium, 2014, lecture “Supply Chain Analysis and Management Rooted in Simulation and Modelling”;
- Tashkent Automobile and Road Construction Institute, Uzbekistan, May 2015, lectures “Modern Information Technologies in Supply Chain Management” (for industry professionals) and “Supply Chain Analysis and Management Rooted in Simulation and Modelling” (for students);
- Bukhara State University, Uzbekistan, May 2015, lecture “Supply Chain Analysis and Management Rooted in Simulation and Modelling”;
- Old Dominion University, Norfolk, Virginia, USA, 24 March, 2016, lecture “Simulation-Related Education and Research: Experiences at the RTU Institute of Information Technology, Riga, Latvia”;

Asoc.prof. A. Romānovs has delivered guest lectures in:

- Autonomous University of Barcelona, Barcelona, Spain, starting in 2014, annual lecture course "Management Information Systems in Business" (16 academic hours) Master Program "Logistics and Supply Chain Management";
- Vilnius Gediminas Technical University, Vilnius, Lithuania, 2018. April, lecture course “Supply Chain Management 4.0” for master students of VGTU Department of Electronics Systems;
- Vel Tech Technical University, Chennai, India, 2018, December, intensive course “Logistics and Supply Chain Management 4.0” for MBA students;
- Metropolitan University of London, London, UK, 2020 February, introductory lecture on blockchain technology in the Baltics and its applications in industry.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

In the reporting period, changes in the composition of academic staff are mostly attributed to (a) replacement of the study courses at the study program; (b) retirement of academic staff or work place change, and (c) attraction of new qualified academic staff for delivery of the study courses.

There were changes in the composition of the academic staff (Fig. 5), namely, the overall number of academic staff at the programme increased from 22 educators in 2013 to 27 educators in 2022. Generally, during the reporting period the number of professors decreased, but the number of associated professors, who previously occupied positions of assistant professors, increased.

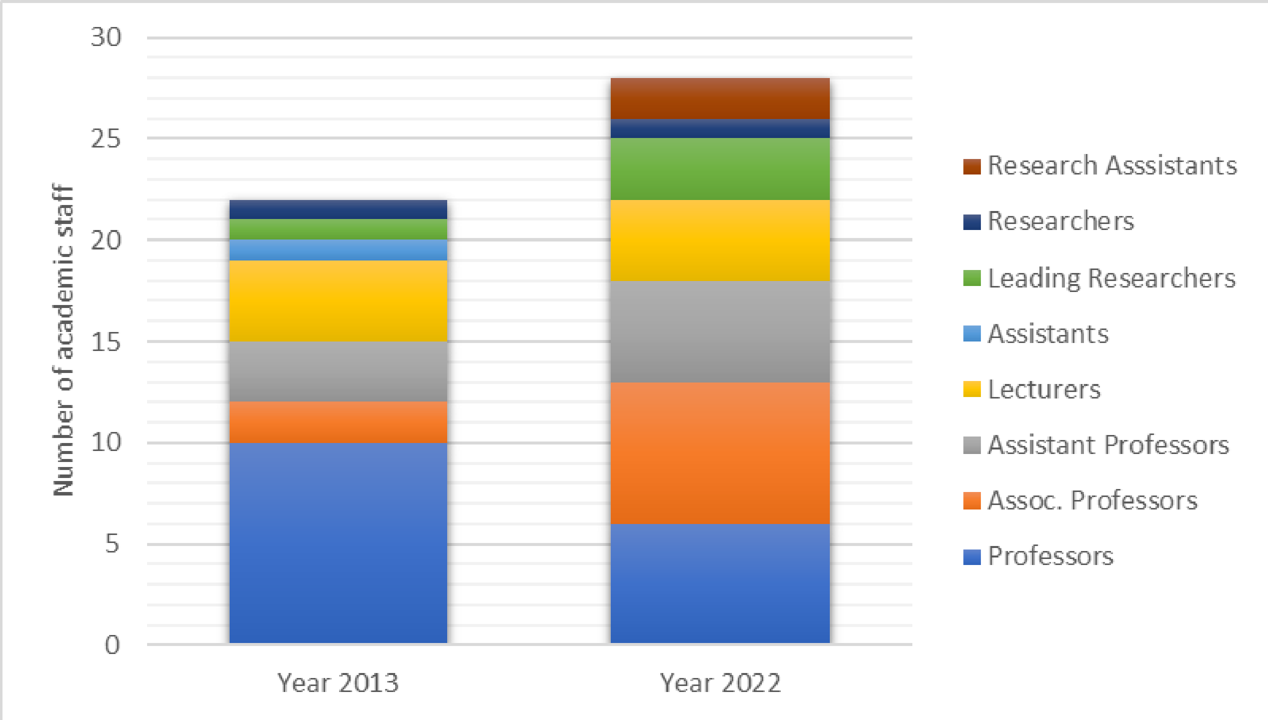


Fig. 5. Changes in the composition of academic staff in the reporting period.

In the reporting period, the proportion of academic staff holding a PhD increased (Fig. 6).

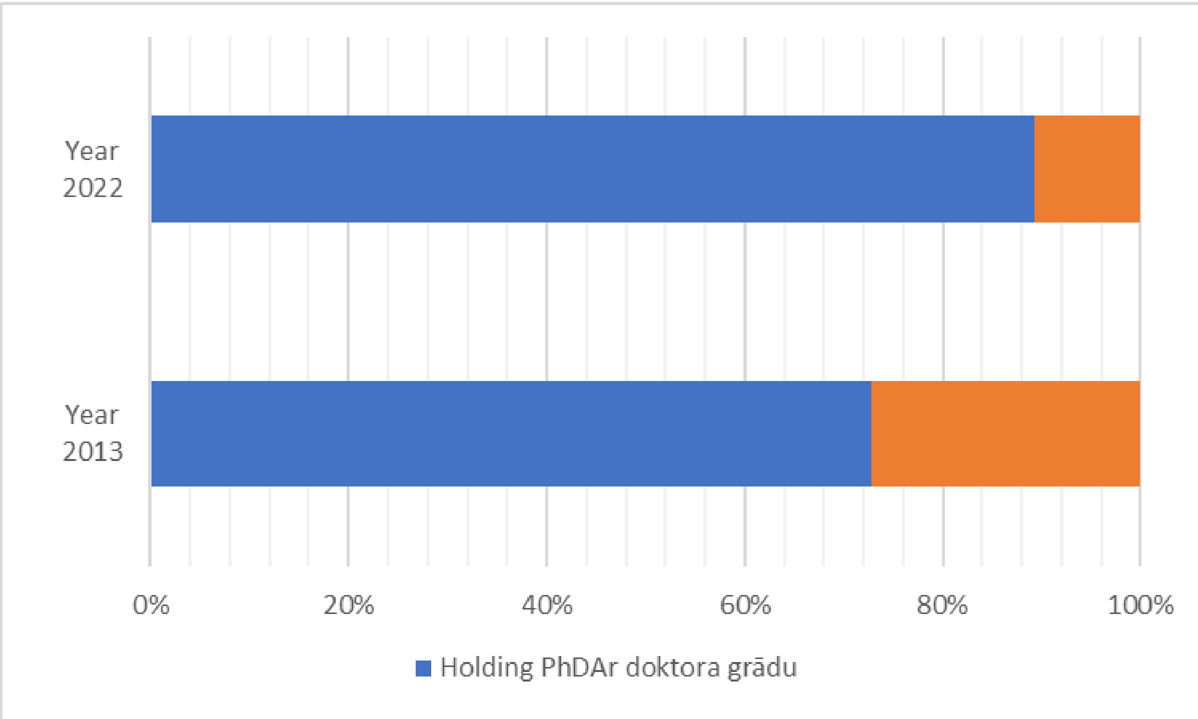


Fig. 6. Proportion of academic staff holding PhD.

The academic staff distribution is appropriate for the needs of the study programme. The proportion of professors and associate professors involved in its realization is in line with that of the world's leading universities.

The changes in the academic staff during the reporting period attest that the study program has a potential for further sustainable development.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The educators involved in the study programme have the necessary skills in order to transfer their knowledge and experience to the students and receive feedback on their work. All members of academic staff are provided with the opportunity to advance their knowledge, take part in professional improvement courses, carrying out research and undergoing training abroad in the framework of exchange programs, take part in scientific conferences, both local and international, as well as publish their research results. Information on the participation of academic staff in conferences and their scientific publications is given in Annex 24.

In the framework of the study programme, academic staff collaborate in delivery of the content of the study courses, improvement of the study curriculum and delivery procedures, and take part in the self-assessment procedure of the study programme. The planning of the study courses provides for successive acquisition of knowledge, and the curricula of the study courses are mutually coordinated. Prior knowledge and previously acquired study courses are indicated in the description of the study courses.

Mutual experience exchange among academic staff takes place at FCSIT and ITI methodological seminars (at the beginning of the study year), regular methodological meetings of the program’s academic staff and industry partners, as well as LSCM methodological conferences organized by RTU in collaboration with partners from UAB (Spain) and UASW (Germany). Three methodological conferences were organized (*Faculty Conference on Logistics and Supply Chain Management*), providing a forum for discussions on the programme curriculum, sequence of the study course, aims, learning outcomes and their conformity to the recent labor market requirements:

- 30 January 2020, Wildau, Berlin, Germany
- 9 March 2016, Riga, Latvia
- 1-3 July 2014, Wildau, Berlin, Germany

At the time of submission of the report, 16 academic staff members are actively involved in the study programme “Logistics and Supply Chain Management”. Accordingly, the number of students is 35:

- 1st year - 12 full-time students and 17 exchange students;
- 2nd year - 6 full-time students.

The study programme supports activities (according to RTU order No. 01000-1.2 / 27), when lecturers participate in the classes of other lecturers, which promotes mutual exchange of experience and collegial cooperation. These activities ar carried out with the aim to get acquainted with the lecturers' work style in general and the methods of solving relevant pedagogical tasks in classes.

The current student/academic staff ratio is ~2.2, which can be explained by a relatively small number of students at the programme and significant restrictions on student mobility in COVID-19 pandemic conditions.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_Diploms_DiplPielikums_LV_Diploma_DiplSupl_ENG.zip	P28_Diploms_DiplPielikums_LV_Diploma_DiplSupl_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DML0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DML0(45526)_AIP_atzinums250stud_Logist_sist_pieg_kedes_vadiba.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DML0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DML0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DML0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf	P06_3.2.1_DML0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DML0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DML0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DML0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DML0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DML0(45526)_StudyCoursesdescr_ENG.zip	P10_DML0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Telecommunications (51523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Telecommunications*
Education classification code	*51523*
Type of the study programme	*Doctoral study programme*
Name of the study programme director	*Vjačeslavs*
Surname of the study programme director	*Bobrovs*
E-mail of the study programme director	*Vjaceslavs.Bobrovs@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*+37127896246*
Goal of the study programme	*The aim of the study programme is to prepare specialists of the highest scientific qualification - Doctors of Science, mainly to carry out the research and pedagogical work in the field of electrical engineering, electronics, information and communication technology science.*
Tasks of the study programme	*- to provide in-depth theoretical knowledge in the fundamental study courses of the study field, as well as to acquire the skill to perform research work and to acquire the skills of scientific discussions; - to develop skills to carry out scientific research on the chosen topic, using experimental and laboratory equipment, modern methods of analysis and data processing; - to develop analytical, creative, and critical thinking skills, as well as cooperation skills; - to provide skills for presentation of research results in international scientific conferences and seminars, to be able to prepare and publish scientific articles on research results; - to develop skills in leadership, ability to work in a team and cooperate with professionals in various fields of science; - to promote the introduction of scientific research in industry, production, and business management; - to improve the skills of scientific, pedagogical, and organizational work.*

Results of the study programme	*- is able to show and understand current scientific theories in the field of telecommunication technologies; - is able to apply the acquired knowledge in solving scientific problems; - is able to independently perform scientific research, pedagogical and organizational work in the field of telecommunications; - is fully aware of the terminology used in the sector, and can communicate about the scientific activity in the field of telecommunications; - is able to carry out scientific and industrial research, introduce innovations and manage complex research and development projects; - is able to manage and implement the academic process (delivery of study courses, evaluation of study results, development of study courses content, management of study programmes); - is able to advance the research ideas in the field of telecommunications, develop, plan, present, implement and manage large-scale international scientific projects in the field of telecommunications; - is able to work independently and in a team to solve scientific problems; - is able to independently improve his/her scientific qualification and manage research or development tasks in companies, institutions, and organizations where extensive research knowledge and skills are required; - is able to analyse the latest development trends in telecommunications technologies and improve knowledge; - is able to independently plan and conduct research with added scientific value in the field of telecommunications, interpret and analyze the results, develop high-level scientific publications.*
Final examination upon the completion of the study programme	*Defence of the Doctoral Thesis at the Promotion Council.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*Master Degree of Engineering Science in Telecommunication Technologies and Networks Management, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address

Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*
Admission requirements (in English)	*Master Degree of Engineering Science in Telecommunication Technologies and Networks Management, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The academic doctoral study programme “Telecommunications” is licensed on 26.12.2000. (licence No 04051-153) and within the review period, changes have been made to study programme parameters. The structure of the programme anticipates an opportunity to plan study courses and scientific research according to each research field and specifics.

The volume of the study programme is 192 credit points (CP) or 288 credit points, according to the European Credit Transfer and Accumulation System (ECTS). The nominal duration is full-time intramural studies (4 years). The type of implementation is full-time intramural studies. In the standard planning of Riga Technical University (RTU), in each study year there are 2 semesters. The length of each semester is 20 weeks - 16 study weeks and 4 session weeks. The study programme is implemented in Riga in Latvian and English languages in the RTU Institute of Telecommunications (IT).

There are following substantial changes to the study programme parameters since the issuance of the previous accreditation form of the study field:

1. The study programme director changed. Currently, the director of the study programme is professor Vjačeslavs Bobrovs. Vjačeslavs Bobrovs has the corresponding qualification and experience in elaboration of the content of higher academic education study programme;
2. The degree obtained until the year 2020 was “Doctor of Engineering Sciences”, and since the year 2020, according to amendments in the Regulations of the Cabinet of Ministers of the Republic of Latvia, is “Doctor of Sciences” (PhD);
3. The following study courses are included in the compulsory elective professional specialisation (B1) part:

- specialisation “Computer Engineering and Networks” RDE717 Hybrid Optical Fibre-Wireless Communication and Networking – 4 CP, RAE713 Management of Telecommunications Projects – 4 CP, RAE714 Telecommunications Network Management – 6 CP;
- Specialisation “Electronic Communications”: RDE714 Quantum Communication – 6 CP, RDE715 Metaphotonics in Telecommunications – 4 CP, RDE716 Microwave Photonics Devices and Systems – 6 CP, RDE718 – Basics of Integrated Photonics – 4 CP.

The content of the study programme has been developed according to the European experience in the creation of interdisciplinary education programmes and is reconciled with the Bologna agreement. It corresponds to the educational standards of the European Union and is adjusted for the current demands of scientific and research institutions and the industry.

The content of the study programme and implementation thereof is based on the existing normative acts and regulations of the Republic of Latvia, principles of doctoral education suggested by the association of European Universities, EQUAL guidelines for doctoral studies of May 2016, observing the strategical development objectives of RTU Faculty of Electronics and

Telecommunications (FET) and United Nations (UN) Sustainable Development Goals in higher education.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The academic doctoral study programme “Telecommunications” comprises research in all telecommunication fields concerning sustainable development consequences of society. The objective of the study programme is to improve the necessary knowledge and skills of students for research work in the field of telecommunications and provide the essential material for the performance of independent research. Doctoral studies can be started after acquiring a master's study programme in telecommunications or a comparable master's level of education.

After defending a Doctoral thesis, study programme graduates obtain a doctor of science (Dr.sc.ing., since 2020 – PhD) in electrical engineering, electronics, information and communication technologies, which meets the upper limit of knowledge and allows solving critical engineering problems in research and innovation, which allows you to start an independent professional, scientific or academic activity, expanding the existing knowledge and providing a new understanding of the topics of the telecommunications industry. The study programme is implemented according to the Law on Higher Education Institutions (02.11.1995), Law on Scientific Activity (19.05.2005.), Education Law (29.10.1998.), Regulation of the Cabinet of Ministers No 1001 “Order and criteria of awarding a doctoral degree in science (promotion)” (27.12.2005.), RTU Constitution, RTU Senate decisions and RTU regulation on doctoral studies. The RTU study programme is implemented by observing the RTU research roadmap and the relevance of creating the scientific and research environment and development directions in Latvia, Europe and the world. It is oriented to the preparation of a new generation of teaching staff and scientists according to the Cabinet of Ministers No 436 “Education development guidelines for years 2021–2027” and other local and international acts.

The result of the study program is an independently developed doctoral thesis with significant theoretical significance and potential for practical use, which includes original scientific research results obtained by independently evaluating and choosing research methodologies and methods appropriate for modern research, and provides new scientific and professional knowledge in the field of telecommunications technology sciences. The educational classification code of the study program is 51523, which combines engineering, electrical engineering, electronics, information and communication technologies and corresponds to the goal of the study program to ensure the acquisition of a scientific degree. The duration of the study program is four years, which is suitable for the development of a doctoral thesis and corresponds to world practice.

In the improvement of the doctoral study programme, the European Qualifications Framework documents, correspondence to the Bologna process and other normative acts are observed.

The study programme gives an opportunity to continue studies for students with a Master's degree in Engineering Sciences in Telecommunications or with comparable education.

The study program is implemented in two languages - Latvian and English. Currently, it is the only program in the Baltic universities where it is possible to acquire high-quality knowledge in the development of communication systems and the creation of their individual elements, as well as to plan the development of future national-scale infrastructure. The use of the English language in the implementation of the study program allows increasing the number of students thanks to foreign applicants, to participate in international student exchange programs and improves the indicators of the implementation of the study program. For the growth of foreign students in the doctoral study program "Telecommunications" in recent years, see the annex P05_3.1.4_EDC0(51523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

For admission of foreign tuition fee-paying students to the study programme, there are additional requirements for a minimal level of English language skills. According to the first part of Article 15 of the Law on Higher Education Institutions and RTU Senate meeting decision of 28th of October 2019 (protocol No 643, "Requirements for the foreign students for enrolment in the study programs and parts of the study programs attached to RTU international cooperation and foreign students department in 2021"), when applying for studies foreigners shall submit a document issued by an international testing institution within the last five years, which certifies that the foreigner has skills of at least B2 level of the implementation language of the corresponding study programme. The mentioned document shall not be submitted if the foreigner acquires secondary education or higher education in the language of the corresponding study programme.

The volume of the programme is 192 CP, and the duration of studies is 4 years (intramural). In doctoral studies, doctoral students acquire compulsory, specialisation and free elective study courses in telecommunications. Students are able to deepen their foreign language knowledge related to professional, scientific, and research topics.

Doctoral studies are primarily conducted in practical classes, where doctoral students perform the tasks given by the instructor using mathematical, analytical, and experimental research methods. During the introductory lectures of study courses, the doctoral student is introduced to the course and the formulated tasks. The doctoral student finishes each study course with a report, which should be submitted to the attestation committee. In the second stage of the study, scientific research is performed within the framework of an individual Doctoral thesis.

The objective of the doctoral study programme is to prepare specialists of the highest scientific qualification - doctors of science, mainly in the science field of Electric equipment, Electronics, Information and Communication Technologies to perform scientific and pedagogic work.

Tasks of the study programme:

- to provide in-depth theoretical knowledge in the fundamental study courses of the study field, as well as to acquire the skill to perform research work and to acquire the skills of scientific discussions;
- to develop skills to carry out scientific research on the chosen topic, using experimental and laboratory equipment, modern methods of analysis and data processing;
- to develop analytical, creative, and critical thinking skills, as well as cooperation skills;
- to provide skills for presentation of research results in international scientific conferences and seminars, to be able to prepare and publish scientific articles on research results;
- to develop skills in leadership, ability to work in a team and cooperate with professionals in various fields of science;
- to promote the introduction of scientific research in industry, production, and business management;
- to improve the skills of scientific, pedagogical, and organizational work.

As the result of doctoral studies, knowledge for further scientific and pedagogical work is obtained, which can be described by such competencies and skills:

- is able to show and understand current scientific theories in the field of telecommunication technologies;
- is able to apply the acquired knowledge in solving scientific problems;
- is able to independently perform scientific, pedagogical and organizational work in the field of telecommunications;
- is fully aware of the terminology used in the sector and can communicate about the scientific activity in the field of telecommunications;
- is able to carry out scientific and industrial research, introduce innovations and manage complex research and development projects;
- is able to manage and implement the academic process (delivery of study courses, evaluation of study results, development of study courses content, management of study programmes);
- is able to advance the research ideas in the field of telecommunications, develop, plan, present, implement and manage large-scale international scientific projects in the field of telecommunications;
- is able to work independently and in a team to solve scientific problems;
- is able to independently improve his/her scientific qualification and manage research or development tasks in companies, institutions, and organizations where extensive research knowledge and skills are required;
- is able to analyse the latest development trends in telecommunications technologies and improve knowledge;
- is able to independently plan and conduct research with added scientific value in the field of telecommunications, interpret and analyze the results, and develop high-level scientific publications.

The programme, with its activity, promotes the keynote defined in the RTU Strategy for the years 2021 – 2025: "High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities in the Baltic and Nordic region, acting based on a study system built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies" and implements it in real life.

The most important contribution of the implementation of the study programme is related to sustainable development and excellence. Special attention is paid to management and strategy planning, process approach, development of products and services, improvement of money flow and finance activity indicators, improvement of efficiency in all fields of activity, raising the level of satisfaction of students, cooperation partners and academic staff.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The telecommunication field has been rapidly developing in Latvia and the world in the last few years. As a result, the quality of electrical communications is at a high level. Indicators of the field do increase, and in the future, a synergy of the field of telecommunications with economics and other national economy fields will be even more important.

The study programme prepares highly qualified experts of international level (doctors of sciences) in the field of engineering sciences, providing theoretical and practical knowledge, which is necessary to perform independent scientific research work and pedagogical work. The content of the study programme and implementation thereof is based on the existing normative acts and regulations of the Republic of Latvia, principles of doctoral education suggested by the association of European Universities, EQUAL guidelines for doctoral studies of May 2016, observing the strategical development objectives of RTU Faculty of Electronics and Telecommunications and United Nations Sustainable Development Goals in higher education. The uniqueness of the study programme is the performance of interdisciplinary research in various fields of telecommunications.

The knowledge acquired during the studies allows one to establish own enterprises, take leading positions in private enterprises or state institutions, and develop high-level engineering projects in the callable scientific technology fields.

In doctoral studies, the intellectual potential is necessary for the country’s economic development is developed. According to the information indicated in the document “Latvia 2030 - Sustainable Development Strategy of Latvia”, sustainable investments into human capital are necessary in order to promote a renewal of human resources; therefore, the demand for experts holding a doctor's degree at the labour market in Latvia is very high. The primary indicator, which confirms the demand, is the graduates' employment. All graduates of the academic study programme are employed. They work primarily in higher educational institutions, the private sector, or various government structures both in Latvia and abroad.

Surveys of graduates provide recommendations for improvement of the study programme:

- Study course rotation by semesters;
- To increase the number of guest lecturers for implementation of the study courses who work in the enterprises of the field;
- Inclusion of new study courses into the study programme.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The study programme demonstrates stable indicators on the number of students and admitted candidates in the review period. The average number of doctoral students in the academic doctoral study programme is 29 per year. The total number of students in the programme was 39 in all four study years. Changes in the number of students are linked to a personal choice of some doctoral students to take an academic leave or terminate doctoral studies.

Each year 7 students are enrolled on average. In the study programme, there are both state budget funded seats and tuition fee covered seats. Costs of the study programme are calculated according to the existing RTU practice and do not exceed EU State costs for the preparation of one student in the corresponding speciality.

For international students, studies require tuition fees, and the number of such students is currently increasing.

In the 1st year of the doctoral study programme “Telecommunications”, there are 3 foreign students. In the 2nd year, there are 2 students.

Table 1: Dynamics of students of the doctoral study programme "Telecommunications" from 2013/2014 until 2021/2022 study years

Study year	Academic doctoral study programme "Telecommunications"							
	Enrolled in the 1st year		Study in the programme			Exmatriculated		
	State	Tuition fee	State	Tuition fee	Active foreign students	With diploma	Academic failure	Due to other reasons
2013/2014	1	-	10	2	-	1	-	1
2014/2015	8	-	16	2	-	2	-	-
2015/2016	14	-	28	1	-	3	-	-
2016/2017	7	-	29	1	-	1	-	4
2017/2018	1	-	29	-	-	-	-	2
2018/2019	9	-	32	-	-	2	-	3
2019/2020	8	2	33	2	2	2	1	4
2020/2021	8	1	39	3	3	-	-	-
2021/2022*	9	2	41	5	5	3	-	1
Average per year	**7**	**1**	**29**	**2**	**1**	**2**	**-**	**2**

*Data until 15.02.2022

Analysing the table data, it is possible to conclude that, in general, the number of doctoral students in the programme is approximately at the same level - around 30 students. However, the number of enrolled doctoral students changes each year. The average number of defended Doctoral theses is 2 (two) theses per study year.

The summarised statistical data for the review period concludes that the number of students exmatriculated from the doctoral studies is not large; on average, it does not exceed the 10% limit of the total number of students. The most common reasons for terminating studies are family circumstances and difficulties combining studies with work because some doctoral students work outside the RTU.

Analysing the dynamics of the number of students in connection with the field development trends, it is anticipated that the number of students will correspond to the state development rate in the future in the study programme. The main influencing factor is the amount of doctoral study scholarship, other opportunities, and financing for studies, which depend on the year of enrolment, for example, various grant acquisition opportunities or an opportunity to employ a potential doctoral student in the national or national or international scientific research project.

Statistical data on the doctoral study program "Telecommunications" is summarized in Appendix

P05_3.1.4_EDC0 (51523) _StatistikaparStud_LV_StatisticsonStudents_ENG.pdf.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The volume of the doctoral study programme is 192 CP, where 150 CP correspond to scientific work, where the major part is elaboration and defence of the Doctoral thesis. Choice, volume, and content of study courses of the doctoral programme are composed so that doctoral students could study telecommunication technologies and the newest trends of creation and management principles thereof and create their own research work on the basis of implementation of new ideas.

The content of the study program and its implementation are based on the existing laws and regulations of the Republic of Latvia, internal laws and regulations of RTU, principles of doctoral education recommended by EUA (European University Association), respecting the strategic development goals of RTU and ETF in higher education. According to its structure and content, the study program is oriented toward the achievement of its basic goals and basic tasks, namely the preparation of young specialists not only for processing a large flow of information but also for a creative approach to the development of the industry and solving problems according to the problems and challenges of the industry, which will make the graduates of the program competitive in the industry. in the field and rapidly developing areas of science. All these results can be achieved during study courses. Therefore, the goals set in the study course descriptions are closely related to the achievable results of the overall program, but the study courses are interconnected and complement each other so that the planned results are achieved after the program is completed. The connection of these courses with the study results of the program is reflected in the study course mapping (see annex P08_3.2.1_EDC0(51523)_Kartejums_lv_Mapping_eng.pdf).

Study courses and scientific research are offered in various subfields of telecommunication engineering, including digital signal processing and coding, digital communications, signal modulation and coding, quantum communications, microwave photonics, microphotonics and integrated photonics, metaphotonics, hybrid optical fibre-wireless communications, high density optical and fibre optical networks, communication network design and optimisation, wireless communications, sensors etc.

According to the trends of the field and recommendations for improvement of the programme content, regular revision of study courses and the programme content is performed. For example, in the study programme, on the basis of the newest tendencies in the field of telecommunication technologies, new study courses have been included - “Hybrid Optical Fibre-Wireless Communication and Networking”, “Quantum Communication”, “Metaphotonics in Telecommunications”, “Microwave Photonics Devices and Systems”, “Basics of Integrated Photonics”, “Quantum Networking”, “Management of Telecommunications Projects” and “Telecommunications Network Management”.

The programme structure and all formal conditions correspond to state normative acts and to the requirements defined in RTU Senate decisions.

If students have not acquired the requirements defined in Environmental Protection Law and Civil Protection Law in lower-level study programmes, students have an opportunity, within the framework of the doctoral study programme, to additionally choose the study course “Civil Defence” in the volume of 1 CP (ICA301) and “Environment and Climate Roadmap” 1CP (VAS038), if in previously acquired programmes such discipline was not included, as well as students of the programme branch in English may choose Latvian language, study course “Latvian language for foreign students” in the volume of 1 CP (VLS711).

As the result of the doctoral studies, doctoral students acquire knowledge and competencies that correspond to the doctor's degree requirements and allow the start of the corresponding scientific and research activity.

Acquisition of the programme is finished by defending the Doctoral thesis (dissertation) at RTU P-08 Promotion Council.

Regulations on finishing the doctoral study programme:

1. RTU Doctoral studies are completed if positive evaluation is acquired in all examinations of the study courses anticipated in the study plan. The Doctoral thesis is submitted for the defence of the degree of doctor of science to the corresponding Promotion Council, and the public defence has been performed.
2. If the applicant for a scientific degree has independently elaborated a Doctoral thesis, and the study results of his/her previous education or professional experience are approved in the order determined by RTU as corresponding to the requirements of the certain doctoral study programme, the applicant has the right to submit the Doctoral thesis for defence.
3. A doctoral student is exmatriculated as an applicant for a scientific degree if, after the successful acquisition of the doctoral study programme, the doctoral student has submitted a Doctoral thesis to the Promotion Council, or there was a pre-defence of a draft of the Doctoral thesis at the meeting of the Promotion Council or Structural Unit, where the chair of the Promotion Council or his/her appointed expert of the field took part, and recommendation is received to submit the work for review in the Promotion Council.
4. A doctoral student is exmatriculated from the RTU for academic failure if, after the successful acquisition of the doctoral study programme, the doctoral student has not pre-defended a draft of the Doctoral thesis at the meeting of the Promotion Council or Structural Unit, where the chair of the Promotion Council or his/her appointed expert of the field took part, and recommendation is not received to submit the work for review in the Promotion Council.
5. The doctor of science degree is granted to a person after a successful defence of the Doctoral

thesis at the Promotion Council.

6. The order for exmatriculation of a doctoral student as an applicant for a scientific degree or exmatriculation of a doctoral student for academic failure is issued by the RTU vice-rector for science on the basis of the decision of the corresponding institute council or the faculty council.
7. The order for granting the degree of doctor of science to a doctoral student and exmatriculation from RTU on the basis of the decision of the Promotion Council about granting the scientific degree is issued by RTU Rector.
8. On the basis of the order about granting the degree of doctor of science to a doctoral student, the RTU vice-rector for science gives an order to issue a Doctor's Diploma. A doctor's Diploma is signed by the RTU Rector and the chair of the corresponding Promotion Council.

The prepared Doctoral thesis (dissertation) is submitted to the Promotion Council, which firstly submits the report for assessment to the State Scientific Qualification Committee, and after receiving positive opinion, appoints opponents and organizes public defence. The degree is awarded after the secret ballot of the members of the Council is positive.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The doctoral study programme "Telecommunications" is the only one in Latvia and the Baltic States, which prepares highly qualified experts of international level (doctors of sciences, PhD) in the field of "Electric equipment, Electronics, Information and Communication Technologies", in the subfields "Computer Engineering and Networks" and "Electronic Communications", providing theoretical and practical knowledge, which is necessary to perform independent scientific research work and pedagogical work, thus providing the intellectual potential and renewal thereof essential for the economic development of the state. The content of the study programme and implementation thereof is based on the existing normative acts and regulations of the Republic of Latvia, principles of doctoral education suggested by the association of European Universities, EQUAL guidelines for doctoral studies of May 2016, observing the strategical development objectives of RTU Faculty of Electronics and Telecommunications and UN Sustainable Development Goals in higher education. On average, at least one or three doctors of science defend their Doctoral theses among the doctoral students in the programme.

Currently, in the higher educational institutions of the Baltic States, this is the only study programme where it is possible to acquire highly qualitative knowledge in the elaboration of communication systems and creation of separate elements thereof, as well as to plan future infrastructure development on a national scale. This required severe financial and human capital resources in the previous years, which resulted in significant achievements in the field of telecommunications.

The study programme is focused on interdisciplinary research in Mathematics, Physics, Electronics, Photonics, Metamaterial, Quantum, Microwave Communications and Fibre Optics, which promotes the development of industrial and innovative activities in Latvia and in the world.

Topics of theoretical works and experimental tasks of the study programme are linked to the most relevant topics in the field. Within the framework of the study programme, the research is performed in scientific fields, where interdisciplinary problems are studied, which are connected with the creation and management of various technological systems, elaboration of single elements of systems, development of new products, technologies and services. Researches occur in specialisation fields linked to computer networks, electronic communications, fibre optical communications, quantum technologies, wireless communication solutions, and metaphotonics. These research fields approve the uniqueness of the study programme, and therefore direct integration of the study programme into study programmes implemented in RTU or other higher educational institutions is not implementable and is not efficient.

In doctoral studies, the intellectual potential necessary for the state's economic development is created. According to the information indicated in the document “Latvia 2030 - Sustainable Development Strategy of Latvia”, sustainable investments into human capital are necessary in order to promote a renewal of human resources; therefore, the demand for experts holding a doctor's degree at the labour market in Latvia is very high. The primary indicator, which confirms the demand, is the graduates' employment. All graduates of the academic doctoral study programme “Telecommunications” are employed. They work primarily in higher educational institutions, the private sector, or various government structures both in Latvia and abroad.

In the study programme, there are both state budget funded seats and tuition fee covered seats. Costs of the study programme are calculated according to the existing RTU practice and do not exceed EU State costs for the preparation of one student in the corresponding speciality.

The objectives set out in the descriptions of study courses are closely connected to standard achievable results of the study programme. Course content completely provides achievement of anticipated study results. Verification and improvement of the study course content are performed regularly; it helps control and renew the content of Studies and teaching methods and keep the achievable results up-to-date.

The main research directions of the doctoral study programme “Telecommunications” are:

- Data transmission systems (fibre optics, wireless and quantum) and functional elements thereof.
- Metaphotonics solutions in optical communications and sensor technologies.

The majority of these research directions are developed within the framework of local and international scientific projects. To achieve research aims in both scientific research projects and the mentioned research directions, students of other Institute of Telecommunications study levels - bachelor and master - are involved with graduation thesis, which contain certain objectives and tasks.

Graduates of the study program have successfully integrated into the labor market, having started work already during their studies, and after graduation work in research laboratories, state structural units, become recognized lecturers at the university, as well as manage business enterprises in the fields of the economy related to the science branches of the study program.

The doctoral scientific degree is awarded:

- for an independently developed and defended doctoral thesis or a similar thematically unified set of scientific publications that contain scientifically original, proven results and provide new insights in the field of telecommunications technologies;
- the doctoral degree applicant has at least five publications in an anonymously peer-reviewed scientific publication indexed in the Web of Science or SCOPUS databases, or included in the

INT1 or INT2 category journals of the ERIH (European Reference Index of the Humanities) database;
- modern data analysis, data processing methods, as well as experimental work in the scientific laboratory, are used in doctoral work;
- research results have been approved at international scientific conferences (seminars).

The named justifies that the awarding of degrees is based on the achievements and knowledge of the relevant scientific branch.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The methods used in the study programme promote the achievement of objectives and results of the study programme and courses, and student-centred education principles are taken into account (further referred to as - SCL). According to definitions in SCL guidelines, involvement of students in the study process and improvement of the content are provided; this creates additional responsibilities and also rights for students. Students are provided with an opportunity to influence their own process of studies and to submit feedback on the process studies. A significant role in the provision of linkage among students, teaching staff and programme administration is given to the RTU FET student self-government, which actively takes part in all the mentioned processes and performs an annual assessment of the teaching staff. In several documents - in Code of Academic Integrity, Regulations of Assessment of Study Results, Methodological guidelines for the elaboration of study and graduation papers - studying and learning guidelines are defined.

The doctoral study program "Telecommunications" has been developed based on the RTU Doctoral Regulations. The duration of full-time doctoral studies is four years. Doctoral studies take place 11 months a year according to the doctoral study schedule for the academic year. The amount of the doctoral study program is 192 credit points. The study plan can be found in the appendix P09_3.2.1_EDC0(51523)_Plans_lv_Plan_eng.pdf.

The study program is implemented in Latvian and English and provides for full-time face-to-face studies. When implementing the content of the program, the requirements formulated in regulatory acts and the basic principles of study process organization determined by RTU are taken into account, as well as all study course requirements are met.

Different study methods and forms are used in the learning process, the choice of which is related to the specifics of each study course. Much attention is devoted to the analysis and compilation of scientific literature, scientific articles and conference materials, as well as independent work in laboratories and with computer equipment and computer modeling. At the end of each semester, students prepare a report with report on the work done in each studied course, as well as on their scientific-research work, for which it is necessary to report and the certification of doctoral students must be reported for each academic year.

The forms of study work are lectures, practical and laboratory work, seminars, study work and pedagogical practice. Active teaching methods are widely used in the classes - discussion of problems in a group, discussions, presentations with reports on the results of scientific work, etc.

Students' independent studies play an important role. The description of their progress is included in the description of the study course as a mandatory component. Student's ability to learn independently is purposefully developed in all study courses and in the framework of scientific work.

The study programme and the study courses included therein are student-centred. Different students, their knowledge, skills and experience, and the variety of needs of doctoral students are taken into account and observed, thus applying individual learning schedules for each. Various types of study course content implementation in the study programme are included. The teaching staff work with students in small groups or individually, allowing the use of various pedagogical learning and teaching methods. The study process is organized in such a way that promotes the independence of doctoral students while providing supervision and support from the teaching staff acting as scientific advisors or mentors. Besides, it promotes mutual respect and facilitates the growth of all parties involved in the study process.

Assessment of study results takes place according to “Regulation for assessment of learning outcomes”.

Descriptions of study courses are available on the RTU homepage and in the register of study programmes. Description thereof is composed using the form, which also includes Bloom’s taxonomy principles, respectfully, indicating not only annotation, short description, but also providing information on the objective and tasks of the study course, which are given in competences and skills, on achievable learning outcomes and assessment thereof, as well as on requirements to the prior knowledge.

In the assessment of studies, according to RTU Senate decisions, a summary achievement assessment approach is used. When starting the study course, doctoral students are introduced to the assessment criteria and methods of the corresponding study subject. Teaching staff has to introduce students to specific assessment criteria of each study course at the time of the first lecture. Such criteria shall be published in the e-study environment of RTU internal network ORTUS.

Assessment results are created to give students an insight into the amount depending on the level of the anticipated learning outcomes they have achieved. Pedagogical methods, study course structure, and assessment methods are chosen by the teaching staff responsible for the study courses according to the programme specifications and the course content and the students’ needs. There are courses and seminars organized for the academic staff about the newest teaching and pedagogical methods, as well as attendance to qualification upgrading courses is promoted at internal events of the Faculty, within RTU and worldwide. RTU academic excellence centre organizes academic staff training events at the university level.

Students receive feedback, which usually advises in relation to the learning process and research skill improvement directions. In all studies, subjects assessment is performed by at least three exam administrators (experts of the corresponding field holding doctor’s degrees), referred to as the examination committee within the programme. At the beginning of each academic year, committee members are reviewed and renewed. In forming the committee, relevant topics of the field, achievements of the teaching staff in the corresponding study year, and students’ feedback are taken into account. Members of the examination committee know testing and examination methods and receive support for the improvement of their skills in their field of competence.

Assessment is consequential; it is equally applicable to all students and is implemented in accordance with the procedures approved by RTU. As it is at all levels, students of the doctoral study programme are also introduced to the existing RTU procedures for consideration of students' appeals.

Achievement of objectives and results of the study courses and the study programme within the framework of the programme is implemented by organizing regular teaching staff seminars and discussions on basic principles of learning outcomes and quality provision. In the study programme, complete implementation of study results is provided. The study results are formulated both at the study programme level and at the study course level. Students are informed about the achievable learning outcomes at the beginning of each study course, and also such information is available in the ORTUS environment. As was mentioned before, a linkage is provided between the achievable results of the study programme and those of the study courses. Mutual linkage of the study courses and succession in the acquisition of the study course content is assessed at least once a year and in addition - in such cases when proposals are received from students. According to the achievable results of the study programme, content and volume in credit points of study courses are created, and in its turn, according to the achievable results of the study course, topics and volume thereof are created. In all study courses, the achievable results are verified with the corresponding assessment methods. Students have an opportunity to contravene assessments of learning outcomes - this is defined in the Regulation for assessment of Learning Outcomes (29.05.2017. Senate decision, protocol No 610).

A significant role is given to independent studies of doctoral students. The description thereof is included in the description of the study course as a compulsory component. The ability of students to learn independently is purposefully developed in all study courses and within the framework of scientific work. Students acquire scientific work skills by regularly working with literature and internet resources, performing scientific research, preparing publications, presentations for conferences etc.

Doctoral students are offered opportunities to use mobilities, where abilities of inter-cultural communication are improved. Especially good cooperation has been established with the Royal Institute of Technology (KTH) - Sweden; Research Institutes of Sweden AB (RISE) - Sweden; Technical University of Denmark (DTU) - Denmark; ITMO University - Russia, Russian Academy of Science Institution of Applied Physics (IAP RAS) – Russia, Interuniversity Microelectronics Centre (IMEC) - Belgium; Eindhoven Technical University (TU/e) – Netherlands; Max Planck Institute for the Science of Light (MPL) - Germany.

Students of the doctoral study programme "Telecommunications" only partly use the opportunities offered by mobilities. This, in most cases, is related to the fact that doctoral students are employed and cannot go to a short term or long-term mobility, as well as to the fact that a part of doctoral students have families and therefore cannot use the mobilities.

A high level of preparation of doctoral students and scientific indicators allow receiving SAM grants for doctoral studies according to the project tender procedure, receiving RTU grants, and being involved and applying for local (RTU platform projects, etc.) and international scale scientific projects.

To make doctoral students able to perform theoretical and experimental scientific and research activities, there are qualitatively equipped RTU FET Institute of Telecommunications laboratories for students, which make it possible to perform high-quality measurements and work with the newest technological equipment. Doctoral students have access to wide scientific and research infrastructure (see item 3.3. of the Study Field Report).

Students are provided with access to large online databases, research and analysis tools. A variety of resources are available for students outside university rooms: RTU Scientific library, scientific databases Web of Science, Scopus, IEEE Xplore, and other online databases.

Implementation of the doctoral study programme is done in close cooperation with the Doctoral thesis advisor. In addition, there are regular semester reports at RTU FET Institute of Telecommunications meetings. In such a way, the implementation mechanism of the study programme allows the provision of achievement of Learning Outcomes.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

The internship is not included in the study programme, but practical knowledge in research is strengthened by the active participation of doctoral students in local and international projects and the fulfilment of contract works. All doctoral students are involved in scientific projects (see statistics in item 3.4.4.).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

The academic doctoral study programme “Telecommunications” comprises research of all telecommunication fields in relation to sustainable development consequences of society. The objective of the study programme is to improve the knowledge and skills necessary for research work in the field of telecommunications and prepare students for the performance of independent research. Doctoral studies can be started after the acquisition of the master's study programme in telecommunications or comparable master-level education.

The basis of the studies is the individual work plan of a doctoral student, which is created taking into account all needs of the doctoral student and specifics of the Doctoral thesis. When choosing study courses, a sample of planning is used, but a student may create an individual plan, taking into account the relation of the study courses. Students have wide opportunities to independently plan the progress of studies in the compulsory study course “Scientific seminars”, where students create and reconcile the planned scientific seminar activities in the Science Committee of FET.

Achievements of the planned learning outcomes of the study course “Scientific seminars” are planned by the doctoral student together with the Doctoral thesis advisor and are reconciled in the Science Committee of FET. Achievements within the study courses are registered in the work plan implementation section, and implementation thereof is approved by the Science Committee of FET. The planned volume of work may be implemented during several semesters.

Assessment of the learning outcomes is done in RTU according to the Regulation for assessment of learning outcomes and the Regulation for Doctoral Studies of Riga Technical University. This anticipates that exams in compulsory study courses are taken before the examination committee of at least three persons. One is the instructor (professor) responsible for the study course, and the other is - a doctor of science with expert rights of the Latvian Council Science (LZP).

Pedagogical methods, study course structure, and assessment methods are chosen by the teaching staff responsible for the study courses, according to the study programme specifications and the study course content and the students' needs. There are courses and seminars organized for the academic staff about the newest teaching and pedagogical methods, as well as attendance to qualification upgrading courses is promoted at internal events of the Faculty, within both the RTU scale and the international scale. RTU academic excellence centre organizes academic staff training events at the university level. Training of the academic staff within the international scale is provided by the participation of RTU in the ERASMUS+ programme.

The teaching staff has to introduce students to specific assessment criteria of each study course at the time of the first lecture. Such criteria shall be published in the e-study environment of the RTU - portal ORTUS.

Elaboration of the Doctoral thesis is controlled at two levels:

- regular meetings with the Doctoral thesis advisor;
- reports at the structural unit institute council meeting (first-year students at least twice per semester, students of other years - at least once per semester).

Implementation of the study programme is done in close cooperation with the Doctoral thesis advisor. In addition, there are reports, which take place each semester at FET Institute of Telecommunications council, and attestation of the doctoral student at the end of the study year (according to RTU Regulation for Doctoral Studies). In such a way, the implementation mechanism of the Study programme allows the provision of achievement of Learning Outcomes.

Doctoral students are transferred to the next study year by order of the Faculty dean, on the basis of the decision of the Faculty Science Committee and observing such minimal requirements in preparation and elaboration of the Doctoral thesis:

1. For the doctoral student of the first year:

- One scientific article is published or accepted for publishing.

2. For the doctoral student of the second year:

- One scientific article is published.
- One scientific article is published or accepted for publishing in a journal.
- The Doctoral thesis is ready by 30% of the total volume of the paper.

3. For the doctoral student of the third year:

- One scientific article is published.
- One scientific article is published in a journal.
- The Doctoral thesis is ready by 75% of the total volume of the paper.

RTU "P-08" Promotion Council, has the right to award a scientific degree of doctor of science (PhD) in the field of Electric equipment, Electronics, Information and Communication Technologies, in the subfields "Computer Engineering and Networks" and "Electronic Communications".

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Doctoral thesis topics (field of research) of students are chosen when applying for admission to studies. At the same time, the programme director recommends a potential scientific advisor for the paper and consultants. When commencing the doctoral studies, for each doctoral student, by order of the RTU vice-rector for science, a Doctoral thesis advisor, supported by the Doctoral studies department, is approved. The topic of the Doctoral thesis is adjusted not long before the defence of the Doctoral thesis.

Doctoral thesis research topics of the doctoral study programme “Telecommunications” - digital signal processing, digital communications, signal modulation and coding, quantum communications and networking, microwave photonics, integrated photonics, metaphotonics, hybrid optical fibre-wireless communications, high density optical and fibre optical networks, communication network design and optimisation, wireless communications, sensors etc.

The elaborated study programme is oriented to the solution of problems of such research topics because its objective is to prepare internationally competitive experts of the highest qualification in the field of telecommunications for academic and scientific work in universities, science and research centres as well as for work at state, private and international institutions, which have developed skills related to telecommunication technologies, are able to solve problems, also in research and innovation critically, are able to give new apprehension and solutions. Assessment of the Doctoral thesis is performed according to Regulations of the Cabinet of Ministers of 27.12.2005. No 1001 “Order and criteria of awarding a doctoral degree in science (promotion)”, which is done by the Promotion Council, review of three reviewers and public defence of the Doctoral thesis provide a mutual relation between the doctoral study programme results and the fulfilment thereof.

Graduates of the doctoral study programme “Telecommunications” have performed research in RTU FET IT research directions:

- Data transmission systems (fibre optics, wireless and quantum) and functional elements thereof.
- Metaphotonics solutions in optical communications and sensor technologies.

<u>Doctoral theses defended within the review period:</u>

- **In 2013/2014** study year in the doctoral study programme “Telecommunications”, 1 doctoral student graduated and defended the Doctoral thesis.
- **In 2014/2015** study year in the doctoral study programme “Telecommunications”, 1 doctoral student graduated and defended the Doctoral thesis.
- **In 2015/2016** study year in the doctoral study programme “Telecommunications”, 3 doctoral students graduated and defended Doctoral theses.
- **In 2016/2017** study year in the doctoral study programme “Telecommunications”, 2 doctoral students graduated and defended Doctoral theses.
- **In 2017/2018** study year in the doctoral study programme “Telecommunications”, 1 doctoral student graduated and defended the Doctoral thesis.
- **In 2019/2020** study year in the doctoral study programme “Telecommunications”, 4 doctoral students graduated and defended Doctoral theses.
- **In 2021/2022** study year in the doctoral study programme “Telecommunications”, 4 doctoral students graduated and defended Doctoral theses.

The elaborated research and developed Doctoral theses are of high added value in the development of science and the national economy.

80% of graduates of the doctoral study programme continue working in higher educational institutions or give lectures, where the results of the research performed within the Doctoral theses are included in the content of the study process, which provides knowledge transfer and further application thereof.

In its turn, the majority (90%) of knowledge and know-how obtained in Doctoral theses of doctoral students are integrated into new research project applications.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The RTU has a decentralized budget; therefore, each structural unit has a separate budget. The budget generally means a plan of incomes and expenses for a certain time period, work, event or a function. The RTU incomes and expenses are administrated by the principles approved by the Senate or by the vice-rector for finances with assigned powers. Income can be of such categories, which are allocated to a structural unit for work, for which it is responsible, for example, provision of consultations, organisation of trainings, and which are allocated to a structural unit as the result of calculations, on the basis of the volume of the planned works and/or indicators obtained in the previous periods (i.e., science support). In the RTU, for each structural unit director, remote access to operational and financial information about the structural unit budget is provided, including the planned volume of works and the corresponding financing in the following periods for implementation of the study programme and the study courses. At the beginning of each finance or budget year, the structural unit director plans the work of the structural unit, including salaries of the academic staff subordinated to the certain structural unit director, and elaborates the procurement plan for the next year according to the provision of the study programme or the study course activities and development etc.

For the implementation of the study programme and achievement of the learning outcomes each year, material and technical provisions are assessed, and the study and science provision base, including printed and digital editions.

According to the volume of the programme financing, regular renewal and improvement of resources and software are performed.

In the implementation of the programme, such material resource base is used:

- rooms (for both lectures and practical classes);
- modelling computer laboratories;
- experimental laboratories;
- methodological cabinet;

- RTU Scientific library book and periodic material storage.

There are other RTU infrastructure elements available for the needs of students and instructors - canteens and cafés, copying rooms, student hostels, RTU sport and recreation centres, swimming pools etc. In RTU rooms, there are trading automates installed for buying various drinks and snacks, and drinking water is available free of charge. Information storages are regularly renewed and appended with regular and periodic leading world professional and scientific editions and books in the field.

The University library is of significant importance for the implementation of the methodological and informative provision of the student. RTU Scientific library is the official state-level library, which obtained its status as a result of accreditation. The library provides all the necessary information for the RTU study process and research activities and performs library, bibliographic and information services for RTU students, academic staff, and employees. In the library collection, there are 1.4 million printed documents and e-resources in the databases corresponding to the RTU fields. Students have access to the databases for which the RTU library is subscribed:

- **EBSCOHOST eBook Academic Collection** - eBook Academic Collection database contains ~202200 books in various science fields: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.
- **IEEE Xplore Digital Library (IEEE/IET Electronic Library)** - IEEE Xplore Digital Library is the most extensive database packet, where all IEEE/IET full-text journals, conference materials, and collections of scientific papers are available.
- **E-journal and e-book search** - with the help of SFX software, it is possible to precisely define the location of an e-resource (e-journal, e-book) in the RTU Scientific Library subscribed and free access databases.
- **SpringerLink** database e-books, available are 18500 e-books (issued within 2014 -2020) in the fields: of computer sciences; engineering sciences.
- **Web of Science** is the leading research platform of electronic resources. The unified platform provides an integrated approach for high-quality literature, and it unites the search for information in bibliographic (also citation index) databases, helps find the newest and the most important scientific publications in the journals with high influence factor, collections of conference proceedings etc., as well as show citation of scientific publications.
- **Latvian standard database** content: Latvian national standards (LVS); European standards adapted to Latvian standard status (EN); International standards adapted to Latvian standard status (ISO); annexes to standards: amendments and corrections. Thematic arrangement corresponds to the internationally accepted International classification for Standards (ICS). Standards can be searched by number and can be read.
- **EBSCOHOST -** EBSCO databases comprise periodical publications in computer sciences, engineering sciences, humanitarian and social sciences, economics, business, medicine and other fields.
- **ProQuest Ebook Central** (earlier Ebrary) database provides an opportunity to read scientific books in electronic format. In the ProQuest Ebook Central platform, a collection of electronic books «Academic Complete» is available, where about 200000 e-books in English in PDF format are found, which were published by the world-leading scientific editions – Elsevier, Wiley, Springer, Oxford Press, Emerald etc.
- **ScienceDirect** is one of the largest databases of scientific, technical and medical articles in the world, which comprises full texts of Elsevier Science edition journals.
- **SCOPUS** (publisher Elsevier) – a bibliographic citation database of scientific literature created by scientists for fast acquisition of information.

- **ACM Digital Library** offers high-quality publications in computer science – computer security, computer graphics, acquisition of information, mobile technologies, software development etc.
- **WILEY Online Library** database offers a packet of full text scientific reviewed journals „Full Collection".
- **Letonika** is a Latvian information and translation system on the Internet; the main objective is to provide systematized encyclopaedic data and information on the translation by creating new, existing, and maintaining digital resources about Latvia.
- **Learning material repository – MERLOT** is the largest free access storage of learning materials in the world, which contains more than 28000 materials and an opportunity to attach own learning materials. Here are also links to more than 500 other learning material repositories, creating unlimited opportunities for online browsing of learning material.

Doctoral students are provided with a workplace in the Institute of Telecommunicationsrooms and free access to scientific resources.

RTU Institute of Telecommunications provides academic and methodological work: creates and renews study course descriptions, provides instruction of the corresponding courses (including practical, laboratory and seminars classes), conduction of graduation papers and the defence thereof, and performs other activities related to academic, methodological and scientific work.

The doctoral study programme "Telecommunications" is implemented in the building of FET – Azenes street 12, Riga. The environment therein corresponds to the modern requirements. In the building, there is a lift, facilities for persons with reduced mobility and application guides. At entrances, there are no steps, which would obstruct mobility for persons in wheelchairs. Glass doors and revolving doors have markings on them. Stairs are designed for persons with visual disabilities. It is possible to move on the wheelchair on the premises because there are no steps and thresholds in the rooms and between them. All the classrooms anticipated for the study process are equipped with multimedia devices - a computer with access to the Internet, a speaker system, projector. Thus, it is possible to provide the modern study process.

In recent years, RTU Institute of Telecommunications, attracting private company, State and European Union financing, and scientific research projects, has significantly developed the research direction – **data transmission systems (fibre optics, wireless and quantum) and functional elements thereof.**

In the course of development in 2019, TI created the Communication Technologies Research Centre (RTU ComTech), one of the leading experts in Fibre optical transmission systems (FOTS) in the Baltic Region. RTU ComTech is to perform excellent and internationally recognized research, provide development of innovations, make measurements and prepare experiments for scientific institutions and commercial enterprises, and support the learning process in the field of Information and Communication Technologies (ICT). Now, the Centre serves as a joining structure in the Institute by focusing its scientific activities, including research activities from the transmission systems group, telecommunication networks group, and transport electronics and telematics group. In such a way, interdisciplinarity and development of new innovative technologies in the fields of engineering and information and communication technologies (ICT) are directly fostered.

In applied and fundamental scientific FOTS research laboratories of the RTU Institute of Telecommunications Centre, which are available for RTU students of all study levels, there are modern world level scientific devices and infrastructure, which allows perform innovative researches in such directions as: wavelength division multiplexing (WDM) and time division multiplexing (TDM) fibre optical communication systems, passive optical networks, fibre to the home (FTHH), optical frequency combs or multi-wave light sources, radio over fibre communication

Systems, advanced modulation formats, signal coding, encryption and forward error correction (FEC), hybrid optical signal amplifiers and elaboration thereof, optical fibre Bragg grating sensors for monitoring the technical conditions of constructions (roads, bridges, buildings), non-linear optical processes in transmission systems, quantum communications and quantum noise, complete optical signal regeneration, mathematical modelling of wired and wireless communication networks and components thereof, complex signal processing in transport navigation systems, modelling thereof in wireless networks, study of hybrid Wi-Fi and 4G/5G technologies for application in transport networks, study of energy effective sensor networks and topologies thereof, elaboration of machine learning technologies and application thereof in computer networks.

The equipment available for the learning process in RTU Institute of Telecommunications laboratories includes various hundreds of significant devices and components, also such modern devices as the newest Z-Series Keysight DSOZ334A 4 channel 33 GHz and 80 GSa/s oscilloscopes, Keysight M8195A arbitrary waveform signal generator, which provide students an opportunity to generate test signals of any form and complexity (i.e. 4G, LTE signals, PRBS sequences, etc.), Anritsu pulse pattern generators and error detectors (up to 32 GHz, MU183020A, MU183040B), Anritsu MG3693C microwave signal generator with analogue bandwidth up to 31.8 GHz, Anritsu MP1026A 12.5 GHz eye pattern, fixed wavelength and adjustable laser sources (850 nm, 1300 nm, 1310 nm, 1500 nm, 1465 nm to 1575 nm, 1525-1625 nm, with up to +16 dBm output power), pumped and wide-band light sources (LED, SLED, ASE, Fabry-Perot, 915 nm and 980 nm laser diodes, 10W 975 nm laser diodes), various type of optical fibre coils (single mode SMF, multi-mode MMF, NZ-DSF, high non-linearity fibre (HNLF), Erbium (Er3+) doped SMF, Ytterbium (Yb) doped SMF, polymer optical fibre (POF), double-shell Er-Yb doped optical fibre, dispersion compensation fibre (DCF), up to 50 GHz PIN photodetectors, 20 GHz balanced optical receiver, K frequency band RF components: Pasternack 20 dB amplifying - 40 GHz (K-band) funnel type aerial, SAGE 40 dB amplifying and from 18 to 40 GHz low noise amplifier (LNA), Spacek Labs K-band millimetre wave amplitude detector, Mini-Circuits Low Pass Filter (LPF), Marki K-band band-pass filter, from 18 to 50 GHz balanced mixer, Standa vibration isolation systems (special optical tables), Finisar 10WSAA09FLL adjustable wavelength filter (WSS) with record-low 6.25 GHz optical resolution and signal power equalisation opportunities, optical modern fibre arc discharge fusion splicing machines (Sumitomo and Fujikura), industrial microscope cameras with 4K resolution and 300x zoom, fibre and micro-optical positioning elements: dust-resistant bounding box, high precision Thorlabs 3 axial micropositioners, Thorlabs high precision rotation surfaces, high precision differential micrometers, Thorlabs piezo controllers, EXFO and other producers' optical signal power meters (190 – 2000 nm, -50 dBm up to +40 dBm), Exfo adjustable and Thorlabs fixed optical attenuators, various high frequency (RF) device components (Anritsu and Pasternack adapters, splitters, distributors, cables, pick-of-tees, bias-tees, adjustable and fixed RF attenuators, wide-band amplifiers), Advantest and Anritsu optical (from 600 nm to 1750 nm) spectrum analyser, to Thorlabs 40 GHz external phase and intensity optical modulators, Teraxion adjustable dispersion compensation module, fixed and by wavelength and band width adjustable optical filters (FBG, FP, TFF), EXFO Chromatic Dispersion (CD) and polarisation mode dispersion (PMD) analysers, optical fibre Bragg grating and temperature and pressure sensors, EXFO, Yokogava and Anritsu optical time domain reflectometers (OTDR), Fiberpro and Thorlabs optical signal polarization controllers and polarisation position measuring devices. This material and technical base, which is continuously being renewed and appended, provides an opportunity for students to elaborate their own communications systems and signal experimental processing models, validate technologies in various technology readiness levels (TRL) as well as perform high precision electrical and optical signal measurements, including wireless signals. Moreover, students have access to the most modern simulation and computation software, including Matlab, VPIphotonics, Synopsys OptSim, AutoCAD, PSpice, SolidWorks, COMSOL, OriginPro, etc.

In the institute, there is also a **Laboratory of the Internet of Things (IoT)**, which has been established in cooperation with the enterprise Siemens Latvija and is mainly designed for various industrial IoT solutions and the creation of sensor networks. In the laboratory, there are various devices, for example, programmable logic controllers (LOGO, SIMATIC S7 1200), micro controllers (Arduino, ESP), Bluetooth, ZigBee, LoRa, NrF 24, 4G radio receivers, IP network gateways (Simatic IOT 2040, Raspberry PI) as well as various training sets. The research activities are mostly connected with the collection of various electronic sensor data and sending them within the IP network. For data aggregation and processing, students and scientists have access to the IoT cloud platform Siemens MindSphere.

And also, in the last year, the research direction has been formulated as "**Metaphotonics solutions in optical communications and sensor technologies"**. The application of dielectric nano photonics is very diverse, for example, waveguides, modulators, directed emitters and nano aerials, detectors, masking and invisibility devices. The development of dielectric nano photonics has already allowed the creation of various meta surfaces, materials and meta systems, and nanophotonics provides optical conductivity almost without losses. Though now there is a need for new, particularly thin photonic elements, which can effectively control particularly short laser pulses, this cannot be implemented by the above-mentioned nanophotonics devices with a few exceptions. Currently, we are experiencing unexpectedly rapid data transfer rates through optical fibre communication networks because the number of end-users and newly developed services is growing (for example, high-quality video streaming, video conferences, wide and virtual reality, remote offices (work from home) etc.), which was induced by COVID-19 world pandemic. And also, the integrated quantum photonics in the telecommunication data transmission band (configurable quantum photonics schemes for telecommunication wave length using femtosecond laser micro mechanic processing) has large future potential by improving the classical optical network infrastructure elaborated for communication. In the last ten years, increasingly larger attention is drawn to optical structures of semiconductor nano particles with high refraction index and minor losses in the optical band (i.e. Si, TiO2). The reaction of such structures to continuous radiation is studied in detail; as a result, there are many new optical effects obtained, which come from the ability to excite both electric and magnetic multi-pole momentums with low absorption in such nano particles. On the basis of the observed phenomena, particularly thin optical systems with absolutely new functionality are elaborated. Active research activities are performed to study the time dynamics of the state, which in stationary mode is not dispersed (dark mode), and meta surfaces, which are almost transparent from such types of particles. In more details, nano particles and meta surfaces are studied in anapole and hybrid-anapole mode and the meta surfaces in the destructive Fano resonance domain. For such states, which are similar in the stationary mode, the pattern of modes is completely different, which will create various dynamical effects. A combination of completely different properties in continuous and pulse modes gives an opportunity to elaborate new optical elements with ambivalent functionality (for example, new particularly thin dynamic mirrors, filters, modulators etc.), which currently do not exist.

Methodological materials are regularly updated and uploaded by the teaching staff in the ORTUS environment for all study courses.

The study process is provided mainly by RTU FET Institute of Telecommunications staff.

For the provision of quality, a digital student survey system is used, which helps control the quality of study course and study programme implementation in each semester. On the basis of the quality control results, regular measures for improvement of the study programme and processes are performed.

The total assessment of the resources is reflected in the data provided in part II, Section3, criteria

3.1.-3.3. of the Study Field Report.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Cooperation with the leading international universities and research institutes provides both a unique experimental base and scientific and methodological expertise by creating joint publications within the framework of cooperation. Several doctoral students have elaborated parts of their research papers in foreign and Latvian universities and research institutes.

- Dr.sc.ing. S.Spolītis, in the process of elaboration of the Doctoral thesis, within the framework of the Erasmus programme, performed a part of experiments in the **Photonics Institute (DTU Fotonik) of the Technical University of Denmark (DTU), in the Metro-Access & Short Range Systems Group**. Thereafter, the cooperation, which started within the framework of the Doctoral thesis, with **Eindhoven Technical University, in the Netherlands** was continued within the framework of the post-doctoral (Postdoc) project “Next-Generation High-Speed Fiber Optical Access Systems (NG-FAST)” (01.01.2018 – 31.12.2020). The project addresses the challenges of developing high-speed fibre optical access systems that are more spectral efficient and potentially provide higher data transmission speeds.
- Dr.sc.ing. A.Supe, within the framework of the post-doctoral (Postdoc) project “All-optical Signal Regeneration Using Nonlinear Optical Effects” (01.12.2017 – 30.11.2020), started cooperation with **Aveiro University, Aveiro, Portugal**. The objective of the project is to research and develop the all-optical signal regeneration technology, which includes applicability in single-channel and multi-channel fibre optical transmission systems.
- Dr.sc.ing. S.Matsenko within the framework of the post-doctoral (Postdoc) project “Generation of Concatenated Forward Error Correction Codes for High-Speed Optical Communication Networks (FECON)” (01.03.2020 – 28.02.2023), started cooperation with **the Research Institutes of Sweden RISE**. The objective of the project is to study and develop valid non-concatenated/concatenated FEC codes for fiber optical communication networks (OCN), where advanced optical signal modulation formats are also used to provide spectral effective data transmission.
- Dr.sc.ing. I.Lyashuk within the framework of the post-doctoral (Postdoc) project “Development of optical frequency combs for fiber-optic communication systems (COMBSYS)” (01.01.2021 – 30.06 2023), started cooperation with **the Russian Academy of Science Federal Research Institution of Applied Physics (IAP RAS)**. The objective of the project is to research and develop various types of optical frequency comb (OFC) generators for fiber optical communication systems to increase data transmission performance, which is particularly important when the society performs remote work from home or studies from home as it was observed in the circumstances of the global COVID-19 epidemiological crisis.
- Dr.sc.ing. E.Grabs, within the framework of the post-doctoral (Postdoc) project “Computer networks traffic management using machine learning techniques” (01.12.2018 – 30.11.2021), started cooperation with **JKU Institute of Applied Statistics, Austria**, to obtain experience in Deep machine learning model creation, analysis of performance thereof, data preparation and application of machine learning algorithms.

- In the process of elaboration of Doctoral theses, doctoral students performed experiments at **the Royal Institute of Technology (KTH), Sweden; Interuniversity Microelectronics Centre (IMEC), Belgium; Eindhoven Technical University (TU/e), Netherlands, Technical University of Denmark (DTU), Denmark.**
- In the process of elaboration of Doctoral theses, doctoral students performed experiments in cooperation with **the University of Latvia (UL or LU in Latvian) Institute of Solid State Physics University of Latvia (ISSP UL or LU CFI)**, **LU Institute of Atomic Physics and Spectroscopy (UL IAPS or LU ASI), Institute of Electronics and Computer Sciences (EDI), Daugavpils University G.Libert's Centre of Innovative Microscopy**.

Scientific and information resources are used jointly with all cooperation universities and research institutes. Knowledge and experience exchange, intensive study programmes, doctoral student and/or academic staff training, project implementations, joint publications and other events are provided. Doctoral students are involved in research projects.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The financing source of the doctoral study programme "Telecommunications" is the funding from the state budget.

In 2021/2022 study year, the programme has 6 state budget financed seats. The tuition fee for the academic doctoral programme "Telecommunications" is 8550 EUR.

Table 2: Information on the financial resources of the programme

Study year	Grant for the programme, EUR	Tuition fee for the programme, EUR		Total financing for the programme, EUR	Financing of one state budget seat, EUR
		Tuition fee for local students, EUR	Tuition fee for international students, EUR		
2013/2014	61636,00	-	-	61636,00	11598,00
2014/2015	77087,24	-	-	77087,24	11598,06
2015/2016	98169,61	-	-	98169,61	11598,06
2016/2017	145114,86	-	-	145114,86	11598,06
2017/2018	121730,25	-	-	121730,25	12121,97

2018/2019	158539,29	-	-	158539,29	12689,04
2019/2020	244393,45	-	-	244393,5	13215,13
2020/2021	270489,16	-	-	270489,16	13388,43

The financing of one study place has increased - in the academic year 2020/2021 by 14% in comparison to the academic year 2013/2014.

The information about the distribution of the funding among cost items is given in the self-assessment report of the study field in the annexe “Distribution of funding among the cost items.”

Information about the minimal number of students in the programme is given in the self-assessment report of the study field in the annex “On_minimal_number_of_students_in_study_programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

Only the teaching staff with high scientific qualifications are involved in implementing the doctoral study programme “Telecommunications” to provide achievement of the objectives of the study courses included in the programme in an efficient and qualitative way. Implementation of the study programme is provided by the academic staff of RTU FET Institute of Telecommunications – professors, associated professors and instructors, all of them being experts in their fields. Justification of the choice of the academic staff is related to the scientific experience, scientific research interests, and scientific contribution, taking into account the specifics of the study programme and the study courses. In the implementation of the programme take part both the academic staff and the teaching staff with work experience in the industry. In total, there are 3 teaching staff and guest lecturers involved in the implementation of the doctoral study programme, who develop their knowledge and competencies in order to improve the quality of studies and refine them according to the demand of the telecommunication field and also to provide modern education to students.

Qualification of the teaching staff corresponds to the implementation requirements of study courses. This is shown by both the descriptive indicators and CV, scientific and methodical inventions of the teaching staff, and their participation in international, Latvian, and RTU organized scientific and methodological conferences, all of which lead their scientific field. In general, the data approve qualification of the teaching staff and show that such qualification is able to provide quality in advising doctoral student studies and scientific work.

All members of the academic staff are shown in the self-assessment of the study field, in part II, Section 3, criteria 3.5 - 3.6, in the data and CVs of the academic staff. This item emphasises competence for delivering certain study courses of the staff involved in the study programme.

Eight representatives of the academic staff involved in the study programme have expert rights of the Latvian Council of Science (LZP). V.Bobrovs has LZP expert rights in nanotechnology. S.Spolītis, V. Bobrovs, Ģ.Ivanovs, J.Poriņš, O.Ozoliņš, X.Pang, A.Supe also have LZP expert rights in Electric Equipment, Electronics, Information and Communication Technologies. LZP expert rights in Physics and Astronomy have S.Spolītis, V.Bobrovs, J.Poriņš, O.Ozoliņš, X.Pang. A.Ozols has LZP expert rights in Material Science. LZP expert rights in Computer Science and Information have O.Ozoliņš, X.Pang and V.Bobrovs.

Qualification of the teaching staff involved in the implementation of the study programme corresponds to the implementation conditions of the study programme and the requirements of the normative acts - all representatives of the teaching staff have doctor’s degrees, and all Doctoral thesis advisers have LZP expert rights.

In the review period for implementation of the study programme, 9 doctors of science joined (Inna Kurbatska, Xiaodan Pang, Aleksandrs Mariņins, Aleksandr Shalin, Elans Grabs, Guntis Ancāns, Sandis Spolītis, Andis Supe, Oskars Ozoliņš) enhancing the list of research fields and opportunities for students to choose the corresponding directions and fields of research.

The teaching staff involved in the implementation of the study courses:

“**Theory of Signal Transmission**” – V.Bobrovs, A.Ozols, E.Grabs, I.Kurbatska; “**Computer Technologies in Telecommunications**” – J.Poriņš, A.Supe; “**Telecommunications and Data Networks**” - J.Poriņš, A.Supe; “**Mobile Telecommunications Systems**” - V.Bobrovs, G.Ancāns; “**Hybrid Optical Fibre-Wireless Communication and Networking**” - X.Pang., O.Ozoliņš, V.Bobrovs; “**Scientific workshop**” – J.Poriņš, O.Ozoliņš, V.Bobrovs; “**Optical Transmission Lines**” - Ģ.Ivanovs, V.Bobrovs, J.Poriņš; “**Electrodynamics of Driving Systems**” – Ģ.Ivanovs, V.Bobrovs, J.Poriņš; “**Quantum Communication**” – O.Ozoliņš, V.Bobrovs, S.Spolītis; “**Metaphotonics in Telecommunications**” – A.Shalin, V.Bobrovs; “**Microwave Photonics Devices and Systems**” – X.Pang., O.Ozoliņš, V.Bobrovs; “**Basics of Integrated Photonics**” – A.Mariņins, V.Bobrovs; “**Management of Telecommunications Projects**” - S.Spolītis, V.Bobrovs; “**Telecommunications Network Management**” – S.Spolītis, V.Bobrovs; “**Research Work**” - J.Poriņš, V.Bobrovs.

The choice of the academic staff is related to their experience in scientific activities and taking into account the specifics of the study programme and the study courses. In the short biographies of the teaching staff listed below qualifications and experience of the academic staff in planning, management and implementation of research projects are shown.

Vjačeslavs Bobrovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: dean of FET. Professional experience: academic and scientific work experience of more than 15 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics, wavelength division multiplexing, passive and active optical networks, microwave telecommunication systems, mobile networks, wireless communication systems), natural sciences - Physics and Astronomy (optical processing physics, conference, optical waveguides, lasers, optical elements, fibre optical elements), engineering sciences and technologies – nanotechnology (nano particles, nano photonics, nano aerials, metaphotonics, anapole state, anapole dynamics, integrated photonics). Director of the academic bachelor's study programme “Telecommunication Technologies and Data Transmission Engineering”, the academic master's study programme “Telecommunication Technologies and Networks Management”, and the academic doctoral study programme “Telecommunications”. Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, RTU Scientific Council, member of the Senate and Constitution Board, member of the RTU Electronics, Information and Communication Technologies, Computer Sciences and Information Science. Member of IEEE since 2012. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 13, co-author for 17 patents. Researcher or project manager in more than 15 projects in total. More than 80 bachelor's papers, 85 master's papers, and 7 Doctoral theses are advised and successfully defended. Participated in ERASMUS academic staff exchange. Regularly participates in professional training and academic seminars.

Jurģis Poriņš, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group: Head of Group. Professional experience: academic and scientific work experience of more than 27 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics; non-linear fibre optics; non-linear optical effects in fibre optics transmission systems; optical wavelength division multiplexing systems and elements; optical amplifiers; safety parameters in communication lines; sensors and sensor networks), natural sciences - Physics and Astronomy (non-linear fibre optics, study and application of non-linear fibre optics effects, polarization effects and assessment thereof, laser equipment, optical amplifiers, optical frequency combs and application thereof). Expert of the Latvian Council of Science (LZP) since 2012 and corresponding member of the Latvian Council of Science (LZP) since 2018. Director of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, Director of FET Council. From 2015 until 28.02.2022 was the dean of FET and administered the Faculty. Member of RTU Council since 01.03.2022. In total, there are 87 publications published in internationally cited editions and reviewed scientific editions and conference proceedings (from them 52 in Scopus database, H-index is 8), as well as 8 scientific monographs, which are available in EBSCO, ISI WEB of Science, INSPEC, VINITI, VERITAS, Intech and other databases. There are 7 articles published in popular science journals. Participated with theses in 82 international and Latvian scientific and technical conferences. Also participated in panel discussions 5G Techritory forum 2020, UL Student scientific conferences in the discussion about the influence of COVID-19 on science and in other events, as well as took the floor radio broadcasts LR1 “Known in the unknown” (in Latvian: "Zināmais nezināmajā"), and also on television broadcasts TV3 and LTV7. 56 bachelor papers, 62 master papers and 2 Doctoral theses are advised and defended. Implements 8 study courses and qualification upgrading courses for representatives of the field of telecommunications. Co-author for 12 patents. Researcher or project manager in 7 projects in total.

Ģirts Ivanovs, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. More than 40 years of experience in the field of higher education: administration of the study process, scientific research, and project management. LZP expert in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies (electrical communications, microwaves, optics, fibre optics, WDM, filters, optical filers, PON, optical amplifiers). For more than 10 years, he has been the director of the Institute of Telecommunications and the director of the academic bachelor, master and doctoral study programme “Telecommunications”. Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, member of Institute of Telecommunications Council, and Member of the Board of the Latvian Telecommunication Association for more than 10 years. Co-author for 85 scientific publications available in the Scopus database, and his H-index is 11, co-author for 11 patents. The professor implements study courses: “Communication Transmission Lines”, “Fiber Optic Transmission Systems”, “Electrodynamics of Driving Systems”, and “Optical Transmission Lines”, as well as participates in the elaboration of the bachelor papers as a scientific advisor. More than 35 bachelor's papers, 40 master's papers, and 4 Doctoral theses are advised and successfully defended. Researcher or project manager in more than 10 projects in total.

Sandis Spolītis, Dr.sc.ing., professor, senior researcher, RTU, FET, Institute of Telecommunications, Communication Technologies Research Centre: head of the centre. Scientific research directions: research and development of innovative fibre optics communication systems, signal processing and coding, optical frequency comb sources, radio over fibre systems, optical processing physics, optical elements and components. Published >80 scientific articles (indexed SCOPUS), 2 monographs. Co-authors of 5 Latvian patents, H-index 10. Participation in >10 international conferences with theses (verbal and stand messages). Advised and successfully defended 18 bachelor's and 17 master's papers, 5 Doctoral theses (2 are defended), administration of the study courses of RTU Faculty of Electronics and Telecommunication, Institute of Telecommunications “Telecommunication systems”, “Scientific workshops in the field of telecommunications” and “Scientific workshops”. The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application-oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Traineeships in the Photonics Institute of the Technical University of Denmark and the Photonics Technologies Integration Centre of the Photonics Integration Institute of Eindhoven Technical University. Member of the RTU Promotion Council RTU P-08 “Electric equipment, Electronics, Information and Communication Technologies”, member of the RTU Constitution Board, member of the Council of RTU Faculty of Electronics and Telecommunications, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of “Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies” and “natural sciences - Physics and Astronomy”. Participation in international scientific associations – IEEE and SPIE. Reviewer of scientific articles of strong influence (Applied Sciences, IEEE Access, Micromachines, Chinese Optics Letters, Fiber and Integrated Optics, Optik, Optics Letters) and a member of international scientific conferences- FOAN, RTUWO, MTTW technical programme committee (TCP).

Andris Ozols, Dr.habil.phys., professor, senior researcher, RTU, Faculty of Materials Science and Applied Chemistry (MLĶF), Technical Physics Institute, Optics Group; Head of Group. Chair of RTU Natural Sciences, Physics and Astronomy Professor Council. The direction of scientific research is material optics, dynamic holography, physics of optical recording and transmission of information. More than 50 years of experience in the field of higher education: administration of the study courses, scientific research, and project management. Since 1998 A. Ozols has been a corresponding member of the Latvian Academy of Science, but since 2010 he has been an academician of LZA. From 2010 until 2016, A. Ozols was elected as a member of the commission of experts of Natural Sciences and Mathematics of the Latvian Council of Science. Currently, he is a vice-chair of the LZA Physics and Technical Sciences Department. Concurrently to the above mentioned, A. Ozols is also a vice-chair of the Joint Council of Astronomy and Physics Professors of RTU and Daugavpils University. LZP expert in the fields of engineering sciences and technologies - Material Science (Solid State Physics, Holography, Laser Spectrography, Photo Induced Processes in Matter, Nano structures, Information Technologies). In 2017 professor Andris Ozols received a Certificate of Appreciation from the Cabinet of Ministers for significant contribution to the development of optical technologies and active participation in the work of Latvian Academy of Sciences. The total number of works: scientific – 253, including 131 scientific articles, from which 75 are published in cited scientific journals; 11 methodological works; 37 popular science articles. The professor is the advisor for bachelor, master and doctoral level students in the subjects related to nanophotonics, theory of electrical communications, physics, signal transmission theory, optical record physics, nano structured nano materials.

Oskars Ozoliņš, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. The research fields are digital signal processing with the help of photonics, components and systems for prompt short-range communication, optical wired and wireless interconnections, optical network monitoring and experience quality forecasting on the basis of machine learning. In his professional career, the associated professor O. Ozoliņš has been a guest researcher in III-V Lab (Nokia Bell Labs and Thales, France), Keysight Technologies (Böblingen Germany), DTU Photonics (Technical University of Denmark, Denmark), IDLab (Ghent University - IMEC, Belgium), OFO (KTH Royal Institute of Technology, Sweden) and PHOTO laboratory (University of Rennes 1, France). O. Ozoliņš is a foreign member of Latvian Academy of Sciences. He is also an expert in the Committees of Technologies, Computer Sciences and Physics of the Latvia - Sweden Research Council. Expert of the Latvian Council of Sciences in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies, and in natural sciences - computer sciences and information sciences. He has more than 13 years of experience in advising students. He advised 36 bachelor's students, 23 master's students, 5 doctoral students and 3 post-doctoral students. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 19, co-author for 8 patents. Researcher or project manager in 8 projects in total. Assoc. professor O. Ozoliņš is a member of EKG2022 Technical Programme Committee (TPC) in Basel, Switzerland and a member of OFC2023 TPC San Diego, California, USA.

Andis Supe, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Institute of Telecommunications, Telecommunication Network Group. Large scientific work experience in the field of fiber optical transmission systems. Participated in the successful implementation of many European Regional Development Fund (ERDF) and European Social Fund (ESF) projects and Latvian National Research Programme. In the period from 2018 until 2020, A. Supe implemented the post-doctoral project "RETUNE", which focused on signal regeneration using non-linear optical effects. During the implementation period of the post-doctoral project, international research work experience was obtained at the Institute of Telecommunications of Aveiro University. A. Supe is a co-author of more than 30 international publications (Scopus data), co-author of 6 Latvian Patents and a member of the international IEEE conference MTTW TCP. He is involved in Latvian Council of Science as an expert in electronics and telecommunications. A. Supe has more than 8 years of academic work experience teaching subjects at bachelor, master and doctoral levels. 23 bachelor papers and 16 master papers are advised and defended.

Xiaodan Pang, Dr.sc.ing., guest associated professor, senior researcher, RTU, FET, Institute of Telecommunications. X.Pang is also a senior researcher at KTH Royal Institute of Technology, Applied Physics department, Stockholm, Sweden. Doctor's degree obtained in the Technical University of Denmark, Kgs. Lyngby, Denmark. Expert of the Latvian Council of Sciences in the fields of engineering sciences and technologies - electric equipment, electronics, information and communication technologies, and in natural sciences - computer sciences and information sciences. Co-author for 243 scientific publications available in the Scopus database, and his H-index is 22. Large experience in digital signal processing, multi-level modulations, radio-over-fibre, mm-waves and THz transmissions, coherent transmissions, Raman amplification, system simulation and laboratory equipment. He regularly reviews journals Optics Express, Optics Letters, IEEE/OSA Journal of Lightwave Technology, IEEE/OSA Journal of Optical Communications and Networking, IEEE Photonics Technology Letters, IEEE Photonics Journals, IEEE Journal of Quantum Electronics, Elsevier Optical Fiber Technology, Optics Communications etc. He advised 4 Doctoral theses (2 are defended). He took part in the implementation of many research projects.

Aleksandr Shalin, Dr.sc.ing., associated guest professor, senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. Assoc. prof. is the head of the “Nano-opto-mechanical” laboratory, senior researcher (associated professor) of the University of Information Technologies, Mechanics and Optics in Saint-Petersburg (ITMO). He advises nine Doctoral theses (6 are defended) and is the senior researcher of five post-doctoral projects. Co-author in 177 scientific publications in Scopus database, H-index: 31, 2 patents. Scientific research fields: dielectric nanophotonics, theoretical near-field optics, nano object optics, plasmonics, optical properties in the heterogeneous environment and meta materials, optical transparency, anti-reflection coverages, meta surfaces, light-absorbing coverages.

Guntis Ancāns, Dr.sc.ing., assistant (docent), senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. The main research interests are radio wave propagation analysis and electromagnetic compatibility among various radio communication systems. Implements study courses “Microwave telecommunication systems”, "Mobile Telecommunications Systems” and “Mobile Network Architecture”. Co-author in 15 scientific publications in Scopus database, H-index: 4. Bachelor’s and master’s papers in the field of mobile communications are advised and consulted.

Elans Grabs, Dr.sc.ing., assistant (docent), senior researcher, RTU, FET, Institute of Telecommunications, Transport Electronics and Telematics Group. Scientific research fields: the leading scientific research field is related to computer network traffic processing, using signal digital processing techniques and machine learning models. New researches are performed in program-defined network creation and study with traffic theory models and neural network classifiers. Published >20 scientific articles (17 Scopus, 11 Web of Science), H-index 3. Participation in >8 international conferences with theses (verbal and stand messages). Participated in the successful implementation of many European Regional Development Fund (ERDF) projects and Latvian National Research Programme. During the implementation period of the post-doctoral project, international research work experience was obtained at the Johannes Kepler University, Austria. Bachelor's and master's papers are advised and consulted. More than 13 bachelor's and 12 master's papers are advised and successfully defended, currently advises/consults 2 doctoral students, including one foreign doctoral student. Preparation and administration of various study courses and classes: “Basics of signal theory”, “Information transmission and digital communication in transport systems”, “Basics of communication systems”, “Online communication systems (study project)”, “Digital processing of signals in transport telecommunication systems”, “Telecommunication software”, “Theory of Electric Communication (special course)” (in English), “Theory of Electric Communications” (in English).

Inna Kurbatska, Dr.sc.ing., assistant (docent), senior researcher, RTU, FET, Institute of Telecommunications. Scientific research fields: fibre optical access networks, passive optical networks, fibre optical transmission system modelling. She elaborated and implemented the study course “Theory of Electric Communications”. She advised, consulted and reviewed many bachelor’s and master’s papers. Co-author in 16 scientific publications in Scopus database, h-index: 3. Implements a post-doctoral ERDF project: “Modelling of the converged Fiber Optical Access Networks”, within the framework of which it is anticipated to perform research, where new specific models for converged networks are developed, thus significantly increasing convergent network modelling and therefore also planning and further research opportunities.

Aleksandrs Mariņins, Dr.sc.ing., assistant (docent), senior researcher, RTU, FET, Institute of Telecommunications, Transmission Systems Group. In 2017 A. Mariņins obtained doctor’s degree in Applied Physics and Photonics in KTH (Royal Institute of Technology), Sweden. He works as a research and development engineer of Silicon Photonics in IMEC (Interuniversity Micro Electronics Centre), Belgium. Co-author in 38 scientific publications in Scopus database, H-index: 6. Research fields: integrated photonics, optical polymers, optical communications, fibre optics, opto-mechanical engineering, open space optics, and semiconductor lasers. He elaborated on a course “Basics of Integrated Photonics”. A.Mariņins has been an internship supervisor for master level students in IMEC Photonics group.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

Within the review period 2013 - 2021, the academic staff list of the study programme significantly changed, and positive dynamics are observed. In the programme, 13 members of the academic staff are employed - 5 professors, 4 associated professors, 3 assistants (docents) and 1 senior researcher. During the review period, 6 members of the academic staff (S.Spolītis, O.Ozoliņš, G.Ancāns, E.Grabs, I.Kurbatska, A.Supe) defended Doctoral theses and obtained the doctoral degree, which allowed to apply for positions of associated professor, senior researcher and assistant (docent). This considerably decreases the average age of the academic staff of the study programme. Three docents became professors in the review period, and one docent became an associated professor. All members of the academic staff have a doctor’s degree.

Changes are also observed in the age structure of the academic staff. In almost all groups of the academic staff, the average age has decreased, which approves academic staff generation change and renewal.

Table 3: Changes and the average age of the academic staff in the doctoral study programme

Teaching Staff	2013/2014		2021/2022	
	Number	Average age, years	Number	Average age, years
Professor	3	69	5	57
Asoc.professor	3	49	4	37
Docent	-	-	3	37
Senior researcher	-	-	1	32
Total	**6**	**59**	**13**	**41**

The main reason of teaching staff to stop their active involvement in the study programme is their retirement age. Tasks of the Faculty of Electronics and Telecommunications are to renew academic and research staff, attract guest lecturers and provide professional growth to the existing staff. For the implementation of tasks, new scientists are attracted to research projects, the number of doctoral students is actively being increased, as well as the number of doctor’s degrees awarded. In this connection important role is given to RTU doctoral studies grants and post-doctoral grants, which allow the attraction of new scientists.

The RTU implements the European Social Fund financed project SAM 8.2.2. “Strengthening of Riga

Technical University academic staff in strategic specialisation fields", where one of the tasks is the renewal of the academic staff. The objective of the project is to strengthen RTU academic staff in strategic specialisation fields in 10 study directions. The project activities are in three directions:

- involvement of doctoral students in the RTU academic work;
- the attraction of foreign academic staff to the RTU;
- improvement of competencies of the existing academic staff, including traineeships of the academic staff in companies.

During the project, it is also possible for the academic staff to take professional English language courses and specialised courses.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

The teaching staff of the doctoral study programme "Telecommunications" perform regular scientific research and scientific publications about research results are prepared. The scientific excellence of the teaching staff is confirmed by the number of scientific publications and citations.

In the period 2014-2022, there are more than 500 publications of the teaching staff of the RTU doctoral study programme, which are published and SCOPUS indexed. It is worth mentioning that these publications of the teaching staff of the doctoral study programme are cited more than 3600 times (7 citations for one publication on average).

Table 4: Number of publications in SCOPUS databases

Year	SCOPUS	Cited (times)
2014	44	239
2015	57	518
2016	57	543
2017	108	740
2018	73	735
2019	80	518
2020	77	241

2021	50	60
2022 (until 01.06.)	8	0

From the data, it is possible to conclude that the results of the research work are very successful; this is confirmed by a large number of publications and projects within the reporting period. The observed decrease in the total number of publications within the last 3 years can be explained by the change in the approach, and more publications are published in scientific journals and are more significant in volume than conference publications.

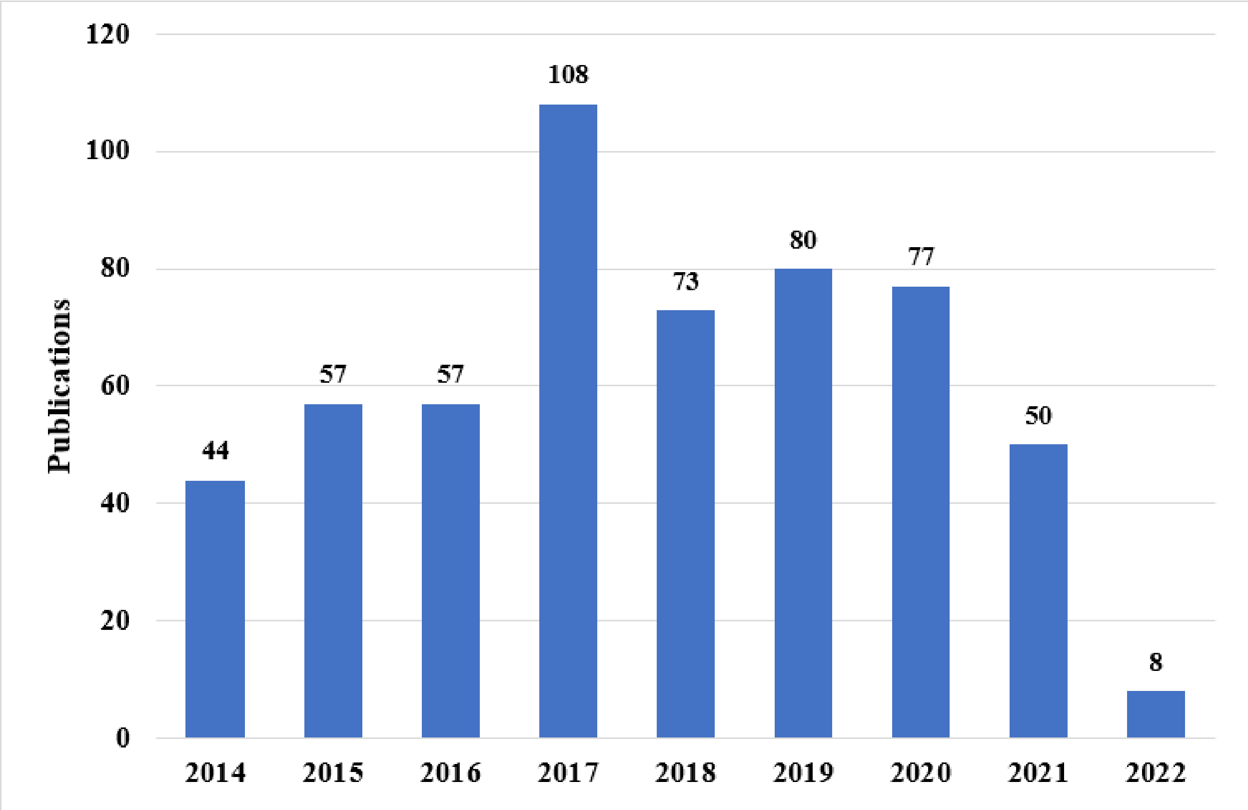


Figure 1: Dynamics of SCOPUS indexed publications of the teaching staff of the doctoral study programme “Telecommunications” from 2014 until 2022.

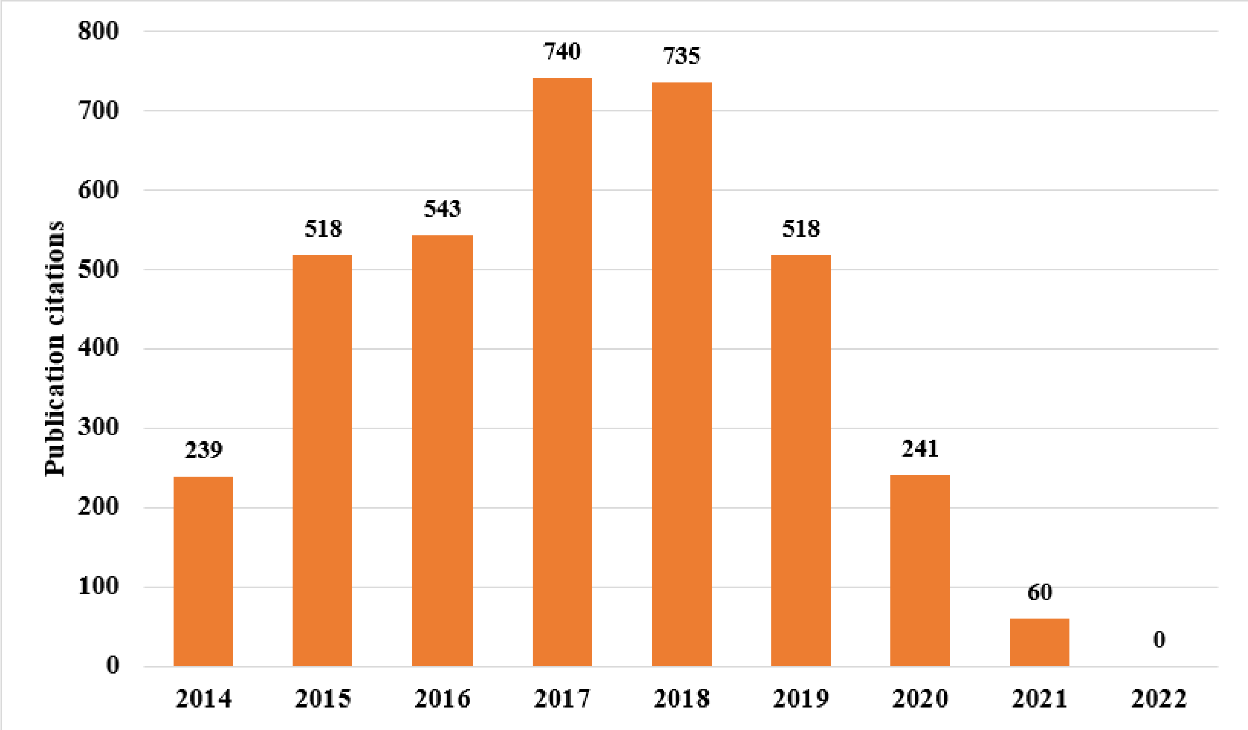


Figure 2: Dynamics of SCOPUS indexed publication citations of the teaching staff of the doctoral study programme "Telecommunications" from 2014 until 2022.

List of scientific publications of the academic staff involved in the implementation of the doctoral study programme in the reporting period:

2022

1. Salgals, T., Alnis, J., Ozolins, O., Andrianov, A.V., Anashkina, E.A., Brice, I., Berkis, , Pang, X., Udalcovs, A., Porins, J., Spolitis, S., Bobrovs, V.. Silica Microsphere WGMR-Based Kerr-OFC Light Source and Its Application for High-Speed IM/DD Short-Reach Optical Interconnects. MDPI Applied Sciences. 2022; 12(9):4722. Available from: https://doi.org/10.3390/app12094722
2. Shalin, A., Kuznetcov, A., Bobrovs, V., Valero, A. Novel Hybrid Anapole State and Non-Huygens' Transparent Metasurfaces. Journal of Physics: Conference Series, 2022, Vol. 2172, Article number 012001. ISSN 1742-6588. e-ISSN 1742-6596. Available from: doi:10.1088/1742-6596/2172/1/012001
3. Valero, A., Shamkhi, H., Kupriianov, A., Tuz, V., Bobrovs, V., Kivshar, Y., Shalin, A. Reaching the Superscattering Regime with BIC Physics. Journal of Physics: Conference Series, 2022, Vol. 2172, Article number 012003. ISSN 1742-6588. e-ISSN 1742-6596. Available from: doi:10.1088/1742-6596/2172/1/012003
4. Ozoliņš, O., Salgals, T., Hadrien, L., Mahdieh, J., Schatz, R., Markus, G., Thomas, D., Benjamin, K., Di, C., Yasuhiro, M., Fan, Y., Udalcovs, A., Lu, Z., Xianbin, Y., Spolītis, S., Bobrovs, V., Popov, S., Pang, X. Optical Amplification-Free 200 Gbaud On-Off Keying Link for Intra-Data Center Communications. In: OFC Proceeding, United States of America, San-Diego, 6-10 March, 2022. USA: OPTICA, 2022, pp.1-6.
5. Pang, X., Hamza, D., Schatz, R., Gacemi, D., Mahdieh, J., Salgals, T., Udalcovs, A., Sun, Y., Fan, Y., Lu, Z., Rodriguez, E., Spolītis, S., Bobrovs, V., Yu, X., Lourdudoss, S., Popov, S., Ozoliņš, O., Vasanelli, A., Sirtori, C. 11 Gb/s LWIR FSO Transmission at 9.6 µm using a Directly-Modulated Quantum Cascade Laser and an Uncooled Quantum Cascade Detector. In: OFC Proceeding, United States of America, San-Diego, 6-10 March, 2022. USA: OPTICA, 2022, pp.1-6.

6. Salgals, T., Alnis, J., Ozoliņš, O., Andrianov, A., Anashkina, E., Brice, I., Berķis, R., Pang, X., Udalcovs, A., Poriņš, J., Spolītis, S., Bobrovs, V. Silica Microsphere WGMR-Based Kerr-OFC Light Source and Its Application for High-Speed IM/DD Short-Reach Optical Interconnects. Applied Sciences, 2022, Vol. 12, No. 9, 1.-15.lpp. ISSN 2076-3417. Available from: doi:10.3390/app12094722
7. Jia, S., Lo, M., Zhang, L., Ozoliņš, O., Udalcovs, A., Kong, D., Pang, X., Gunzman, R., Yu, X., XIao, S., Popov, S., Chen, J., Carpintero, G., Morioka, T., Hu, H., Oxenlowe, L. Integrated dual-laser photonic chip for high-purity carrier generation enabling ultrafast terahertz wireless communications. Nature Communications, 2022, Vol. 12, No. 1388, 1.-8.lpp. Available from: doi:10.1038/s41467-022-2904
8. Kangpeng Ye, Chaoteng Lou, Xingmeng Suo, Yujie Song, Xingxing Feng, Oskars Ozolins, Xiaodan Pang, Lu Zhang, Xianbin Yu, Human Identification by Mean of Optoelectronic Reservoir Computing, 13th International Photonics and OptoElectronics Meetings (POEM 2021), 1215413 (20 January 2022); doi: 10.1117/12.2625789
9. Matsenko, S., Borysenko, O., Spolītis, S., Udalcovs, A., Ģēģere, L., Krotov, A., Ozoliņš, O., Bobrovs, V. FPGA-Implemented Fractal Decoder with Forward Error Cor-rection in Short-Reach Optical Interconnects. Entropy, 2022, Vol. 24, No. 1, Article number 122. ISSN 1099-4300. Available from: doi:10.3390/e24010122
10. Pang, X., Ozoliņš, O., Jia, S., Zhang, L., Schatz, R., Udalcovs, A., Bobrovs, V., Hu, H., Morioko, T., Sun, Y., Chen, J., Lourdudoss, S., Oxenloew, L., Popov, S., Yu, X. Bridging the Terahertz gap: Photonics-assisted Free-Space Communications from the Submillimeter-wave to the Mid-Infrared. Journal of Lightwave Technology, 2022, Vol. 1, No. 1, 1.-15.lpp. ISSN 0733-8724. e-ISSN 1558-2213. Available from: doi:10.1109/JLT.2022.3153139
11. Pavlovs, D., Bobrovs, V., Alševska, A., Parfjonovs, M., Ivanovs, Ģ. Investigation of Power Efficiency Changes in DWDM Systems Replacing Erbium-Doped Amplifiers by Semiconductor Optical Amplifiers. *Latvian Journal of Physics and Technical Sciences*, 2022, Vol. 59, No. 1, 44.-52.lpp. e-ISSN 0868-8257. Available from: doi:10.2478/lpts-2022-0005
12. Ancāns, A., Pētersons, E., Jerjomins, R., Grabs, E., Ancāns, G., Ipatovs, A. Evaluation of Received Signal Power Level and Throughput Depending on Distance to Transmitter in Testbed for Automotive WLAN IEEE 802.11ac Communication Network. *Latvian Journal of Physics and Technical Sciences*, 2022, Vol. 59, No. 1, 3.-12.lpp. ISSN 0868-8257. e-ISSN 2255-8896. Available from: doi:10.2478/lpts-2022-0001
13. Stafecka, A., Lizunovs, A., Ivanovs, Ģ., Bobrovs, V. Dependence between Signal Parameter Values and Perceived Internet Access Service QoS in Mobile Networks. In: Progress in Electromagnetics Research Symposium, China, Hangzhou, 22-22 November 2021. Piscataway: IEEE, 2022, pp.${pageFrom}-${pageTo}. ISSN 1559-9450.

2021

1. Borysenko, O., Matsenko, S., Bobrovs, V. Binomial Number System. Applied Sciences, 2021, Vol. 11, No. 23, Article number 11110. ISSN 2076-3417. Available from: doi:10.3390/app112311110
2. Vagale, I., Lipenbergs, E., Bobrovs, V., Ivanovs, Ģ. Development of Internet Measurement Principles for Representation of Measured Provision of Service (QoS-2). Journal of Information and Telecommunication, 2021, Vol. 5, No. 2, 267.-287.lpp. ISSN 2475-1839. e-ISSN 2475-1847. Available from: doi:10.1080/24751839.2020.1847490
3. Supe, A., Zaķis, K., Ģēģere, L., Redka, D., Poriņš, J., Spolītis, S., Bobrovs, V. Raman Assisted Fiber Optical Parametric Amplifier for S-Band Multichannel Transmission System. Fibers, 2021, Vol. 9, No. 2, 1.-11.lpp. ISSN 2079-6439. Available from: doi:10.3390/fib9020009
4. Supe, A., Olonkins, S., Udaļcovs, A., Ģēģere, L., Mūrnieks, R., Prigunovs, D., Seņkāns, U., Grube, J., Elsts, E., Spolītis, S., Ozoliņš, O., Bobrovs, V. Cladding-Pumped Erbium/Ytterbium

Co-Doped Fiber Amplifier for C-Band Operation in Optical Networks. Applied Sciences, 2021, Vol. 11, No. 4, Article number 1702. ISSN 2076-3417. Available from: doi:10.3390/app11041702

5. Salgals, T., Alnis, J., Mūrnieks, R., Brice, I., Poriņš, J., Andrianov, A., Anashkina, E., Spolītis, S., Bobrovs, V. Demonstration of a Fiber Optical Communication System Employing a Silica Microsphere-Based OFC Source. Optics Express, 2021, Vol. 29, No. 7, 10903.-10913.lpp. ISSN 1094-4087. Available from: doi:10.1364/OE.419546
6. Anshkina, E., Bobrovs, V., Salgals, T., Brice, I., Alnis, J., Andrianov, A. Kerr Optical Frequency Combs with Multi-FSR Mode Spacing in Silica Microspheres. IEEE Photonics Technology Letters, 2021, Vol. 33, No. 9, 453.-456.lpp. ISSN 1041-1135. e-ISSN 1941-0174. Available from: doi:10.1109/LPT.2021.3068373
7. Pang, X., Udaļcovs, A., Schatz, R., Bobrovs, V., Jacobsen, G., Popov, S., Ozoliņš, O. Short Reach Communication Technologies for Client-side Optics beyond 400 Gbps. IEEE Photonics Technology Letters, 2021, Vol. 33, No. 18, 66335.-66345.lpp. ISSN 1041-1135. e-ISSN 1941-0174. Available from: doi:10.1109/LPT.2021.3078255
8. Ozoliņš, O., Pang, X., Udaļcovs, A., Schatz, R., Spolītis, S., Bobrovs, V., Jacobsen, G., Popov, S. 100 Gbaud On–Off Keying/Pulse Amplitude Modulation Links in C-Band for Short-Reach Optical Interconnects. Applied Sciences, 2021, Vol. 11, No. 9, 1.-11.lpp. ISSN 2076-3417. Available from: doi:10.3390/app11094284
9. Canos Valero, A., A.Gurvitz, E., A.Benimetskiy, F., A.Pidgayko, D., Samusev, A., B.Evklyuhin, A., Bobrovs, V., Redka, D., I.Tribelsky, M., Rahmani, M., Zangenesh Kamali, K., A.Pavlov, A., E.Miroshnichenko, A., S.Shalin, A. Theory, Observation, and Ultrafast Response of the Hybrid Anapole Regime in Light Scattering. *Laser & Photonics Reviews*, 2021, Vol. 15, No. 10, Article number 2100114. ISSN 1863-8880. e-ISSN 1863-8899. Available from: doi:10.1002/lpor.202100114
10. Sorokin, A., Anashkina, E., Corney, J., Bobrovs, V., Leuchs, G., Andrianov, A. Quantum Simulations on Polarisation Squeezing of Ultrashort Solitons in Optical Fiber with Enlarged Mode Field Area. *Photonics*, 2021, Vol. 8, No. 6, 1.-12.lpp. ISSN 2304-6732. Available from: doi:10.3390/photonics8060226
11. Vagale, I., Lipenbergs, E., Bobrovs, V., Ivanovs, Ģ. Development of Internet Measurement Principles for Representation of Measured Provision of Service (QoS-2). *Journal of Information and Telecommunication*, 2021, Vol. 5, No. 2, 267.-277.lpp.
12. Novitsky, D., S.Shalin, A., Redka, D., Bobrovs, V., V. Novitsky, A. Quasibound States in the Continuum Induced by PT Symmetry Breaking. *Physical Review B*, 2021, Vol. 104, No. 8, Article number 085126. ISSN 2469-9950. e-ISSN 2469-9969. Available from: doi:10.1103/PhysRevB.104.085126
13. Anashkina, E., P.Marisova, M., Salgals, T., Alnis, J., Lyashuk, I., Leuchs, G., Spolītis, S., Bobrovs, V., V.Andrianov, A. Optical Frequency Combs Generated in Silica Microspheres in the Telecommunication C-, U-, and E-Bands. *Photonics*, 2021, Vol. 8, No. 9, Article number 345. ISSN 2304-6732. Available from: doi:10.3390/photonics8090345
14. Kuznetsov, A., Canos Valero, A., Tarkhov, M., Bobrovs, V., Redka, D., S.Shalin, A. Transparent Hybrid Anapole Metasurfaces with Negligible Electromagnetic Coupling for Phase Engineering. *Nanophotonics*, 2021, Vol. 1, No. 1, 1.-14.lpp. ISSN 2192-8614. Available from: doi:10.1515/nanoph-2021-0377
15. Ostrovskis, A., Kurbatska, I., Salgals, T., Spolītis, S., Bobrovs, V. The Architecture of Hybrid Mm-Wave ARoF Super-PON System for 5G Implementation. *Optical Fiber Technology*, 2021, Vol. 67, Article number 102697. ISSN 1068-5200. Available from: doi:10.1016/j.yofte.2021.102697
16. Braunfelds, J., Seņkāns, U., Šķēls, P., Janeliukštis, R., Salgals, T., Redka, D., Lyashuk, I., Poriņš, J., Spolītis, S., Haritonovs, V., Bobrovs, V. FBG-Based Sensing for Structural Health Monitoring

of Road Infrastructure. *Journal of Sensors*, 2021, Vol. 2021, Article ID 8850368. ISSN 1687-725X. e-ISSN 1687-7268. Available from: doi:10.1155/2021/8850368

17. Spolītis, S., Mūrnieks, R., Skladova, L., Salgals, T., V. Andrianov, A., P. Marisova, M., Leuchs, G., A. Anashkina, E., Bobrovs, V. IM/DD WDM-PON Communication System based on Optical Frequency Comb Generated in Silica Whispering Gallery Mode Resonator. *IEEE Access*, 2021, Vol. 9, 1.-11.lpp. e-ISSN 2169-3536. Available from: doi:10.1109/ACCESS.2021.3076411
18. Mūrnieks, R., Skladova, L., Braunfelds, J., Lyashuk, I., Supe, A., A.Anashkina, E., V.Andrianov, A., Spolītis, S., Bobrovs, V. Impact of Kerr Optical Frequency Comb Linewidth on the Performance of NRZ-OOK Modulated Fiber Optical Communication System. *Laser Physics*, 2021, Vol. 31, No. 11, Article number 115101. ISSN 1054-660X. e-ISSN 1555-6611. Available from: doi:10.1088/issn.1555-6611
19. Pang, X., Schatz, R., Joharifar, M., Udalcovs, A., Bobrovs, V., Zhang, L., Yu, X., Sun, Y., Maisons, G., Carras, M., Popov, S., Lourdudoss, S., Ozoliņš, O. Direct Modulation and Free-space Transmissions of Up to 6 Gbps Multilevel Signals with A 4.65-μm Quantum Cascade Laser at Room Temperature. *Journal of Lightwave Technology*, 2021, Vol. 39, 1.-8.lpp. ISSN 0733-8724. e-ISSN 1558-2213. Available from: doi:10.1109/JLT.2021.3137963
20. Kislov, D., A.Gurvitz, E., Bobrovs, V., A.Pavlov, A., I.Marques, M., Redka, D., Ginzburg, P., S.Shalin, A. Multipole Engineering of Attractive-Repulsive and Bending Optical Forces. *Advanced Photonics Research*, 2021, Vol. 1, No. 1, 1.-12.lpp. e-ISSN 2699-9293. Available from: doi:10.1002/adpr.202100082
21. Brice, I., Grundsteins, K., Sedulis, A., Salgals, T., Spolītis, S., Bobrovs, V., Alnis, J. Frequency Comb Generation in Whispering Gallery Mode Silica Microsphere Resonators. No: *Proceedings of SPIE. Vol.11672: Laser Resonators, Microresonators, and Beam Control XXIII*, USA, Washington, 6.-11. March, 2021. ASV Online: SPIE Proceedings, 2021, Article number 1167213. ISSN 0277-786X. e-ISSN 1996-756X. Available from: doi:10.1117/12.2577148
22. Kurbatska, I., Ostrovskis, A., Spolītis, S., Bobrovs, V. Impact of the Receiver and Transmitter Bandwidth on the Performance of High-Speed OFDM Signal in Radio-over-Fiber Communication Systems. No: *The 13th International Congress on Ultra Modern Telecommunications and Control Systems (ICUMT 2021): Conference Proceedings*, Czech Respublic, Brno, 25.-27. October, 2021. Piscataway: IEEE, 2021, 1.-6.lpp.
23. Pang, X., Schatz, R., Joharifar, M., Udalcovs, A., Bobrovs, V., Zhang, L., Yu, X., Sun, Y., Popov, S., Lourdudoss, S., Ozoliņš, O. Directly Modulated Quantum Cascade Laser and Its Application in Free-Space Communications. No: *SPIE Proceeding*, China, Nantong, 10.-19. October, 2021. USA: SPIE, 2021, 1.-10.lpp. Available from: doi:10.1117/12.2602236
24. Kurbatska, I., Spolītis, S., Bobrovs, V. Evaluation of the Performance-Affecting Factors in the Converged PON. No: *2021 25th International Conference "Electronics"*, Lithuania, Palanga, 14.-16. October, 2021. Piscataway: IEEE, 2021, 89.-94.lpp. ISBN 978-1-6654-4388-3. e-ISBN 978-1-6654-4387-6. Available from: doi:10.1109/IEEECONF52705.2021.9467482
25. Aleksejeva, M., Lyashuk, I., Kudojars, R., Prigunovs, D., Ortiz, D., Braunfelds, J., Salgals, T., Spolītis, S., Bobrovs, V. Research on Super-PON Communication System with FWM-based Comb Source. No: *2021 Photonics & Electromagnetics Research Symposium (PIERS 2021): Proceedings*, China, Hangzhou, 21.-25. November, 2021. Piscataway, NJ: IEEE, 2021, 2940.-2946.lpp. ISBN 978-1-6654-0988-9. e-ISBN 978-1-7281-7247-7. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS53385.2021.9694669
26. Matsenko, S., Spolītis, S., Borysenko, O., Pudžs, M., Krotov, A., Bobrovs, V. LDPC Code with Fractal Decoder Device for 100 Gbps PAM-M Optical Interconnect. No: *2021 Photonics & Electromagnetics Research Symposium (PIERS 2021): Proceedings*, China, Hangzhou, 22.-22. November, 2021. Piscataway: IEEE, 2021, 2382.-2386.lpp. ISBN 978-1-6654-0988-9. e-ISBN 978-1-7281-7247-7. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS53385.2021.9695128

27. Kurbatska, I., Spolītis, S., Bobrovs, V. The Investigation on the Modeling of the Receiver Sensitivity in the RoF Transmission Systems. No: *2021 Photonics & Electromagnetics Research Symposium (PIERS 2021): Proceedings*, China, Hangzhou, 21.-25. November, 2021. Piscataway: IEEE, 2021, 1020.-1025.lpp. ISBN 978-1-6654-0988-9. e-ISBN 978-1-7281-7247-7. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS53385.2021.9694696
28. Pang, X., Schatz, R., Joharifar, M., Udalcovs, A., Bobrovs, V., Zhang, L., Yu, X., Sun, Y., Popov, S., Lourdudoss, S., Ozoliņš, O. Up to 6 Gbps Mid-Infrared Free-Space Transmission with a Directly Modulated Quantum Cascade Laser. No: *2021 European Conference on Optical Communication (ECOC 2021): Proceedings*, France, Bordeaux, 12.-17. September, 2021. Piscataway: IEEE, 2021, 341.-344.lpp. ISBN 978-1-6654-1150-9. e-ISBN 978-1-6654-3868-1. Available from: doi:10.1109/ECOC52684.2021.9606059
29. Pang, X., Ozoliņš, O., Jia, S., Zhang, L., Schatz, R., Udaļcovs, A., Bobrovs, V., Hu, H., Morioka, T., Sun, Y., Chen, J., Lourdudoss, S., Oxenlove, L., Popov, S., Yu, X. Free-Space Transmissions in the Upper- and Lower-THz Bands Assisted with Photonics. No: *ECOC 2021 Proceedings*, Francija, BORDEAUX, 13.-16. September, 2021. Europe: Elsevier, 2021, 1.-4.lpp. ISBN 978-153864862-9
30. Ancāns, G., Bobrovs, V. Analysis on Frequency Arrangement for the 600MHz Band. No: *PIERS 2021*, China, Hangzhou, 21.-25. November, 2021. Hangzhou: Photonics and Electromagnetics Research Symposium, 2021, 1.-1.lpp.
31. Ancāns, G., Stankevicius, E., Bobrovs, V. Analysis on Coexistence of 5G and Fixed Satellite Service in 3.5 GHz band. No: *PIERS 2021*, China, Hangzhou, 21.-25. November, 2021. Hangzhou: Photonics and Electromagnetics Research Symposium, 2021, 1.-1.lpp.
32. Zaķis, K., Supe, A., Spolītis, S., Olonkins, S., Udaļcovs, A., Grube, J., Elsts, E., Ozoliņš, O., Bobrovs, V. Modelling of Cladding-Pumped Erbium/Ytterbium Co-Doped Fibre Amplifier for C-Band Operation. No: *4th international Conference "Quantum Optics and Photonics 2021": Book of Abstracts*, Latvia, Riga, 22.-23. April 2021. Riga: University of Latvia Press, 2021, 92.-93.lpp. ISBN 978-9934-18-707-0. e-ISBN 978-9934-18-708-7. Available from: doi:10.22364/qoph.ul.2021
33. Grabs, E., Chen, T., Pētersons, E., Efrosinin, D., Ipatovs, A., Klūga, J., Čulkovs, D. Features Extraction for Live Streaming Video Classification with Deep and Convolutional Neural Networks. No: *2021 IEEE Microwave Theory and Techniques in Wireless Communications (MTTW 2021)*, Latvia, Riga, 7.-8. October, 2021. Piscataway: IEEE, 2021, 58.-63.lpp. ISBN 978-1-6654-2470-7. e-ISBN 978-1-6654-2469-1. Available from: doi:10.1109/MTTW53539.2021.9607153

2020

1. Borysenko, O., Matsenko, S., Bobrovs, V. Evaluation of Probability Characteristics of the Indivisible Error Detection Codes. No: *IX Scientific Conference "Scientific Results 2020": PC Technology Center*, Ukraina, Kharkiv, 29.-29. December, 2020. Kharkiv: 2020, 1.-2.lpp.
2. Supe, A., Spolītis, S., Elsts, E., Mūrnieks, R., Doke, G., Seņkāns, U., Matsenko, S., Grube, J., Bobrovs, V. Recent Developments in Cladding-Pumped Doped Fiber Amplifiers for Telecommunications System. No: *2020 22nd International Conference on Transparent Optical Networks (ICTON 2020): Proceedings*, Italy, Bari, 19.-23. July, 2020. Piscataway: IEEE, 2020, 1.-6.lpp. ISBN 978-1-7281-8424-1. e-ISBN 978-1-7281-8423-4. ISSN 2162-7339. e-ISSN 2161-2064. Available from: doi:10.1109/ICTON51198.2020.9203436
3. Grabs, E., Pētersons, E., Ipatovs, A., Čulkovs, D. Supervised Machine Learning based Classification of Video Traffic Types. No: *2020 24th International Conference "Electronics": Proceedings*, Lithuania, Palanga, 15.-17. June, 2020. Piscataway: IEEE, 2020, 83.-86.lpp. ISBN 978-1-7281-5869-3. e-ISBN 978-1-7281-5868-6. Available from: doi:10.1109/IEEECONF49502.2020.9141625

4. Čulkovs, D., Grabs, E., Ipatovs, A. Comparison of MEMS and FOG Gyroscopes for Daily Use in Camera Stabilizing Systems. No: *2020 24th International Conference "Electronics": Proceedings*, Lithuania, Palanga, 15.-17. June, 2020. Piscataway: IEEE, 2020, 63.-66.lpp. ISBN 978-1-7281-5869-3. e-ISBN 978-1-7281-5868-6. Available from: doi:10.1109/IEEECONF49502.2020.9141619
5. Matsenko, S., Spolītis, S., Bobrovs, V. Evaluation of Intensity Modulated WDM FOTS with Interleaved RS-FEC Code Schemes. No: *2020 International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2020): Proceedings*, Croatia, Hvar, 17.-19. September, 2020. Piscataway: IEEE, 2020, 207.-210.lpp. ISBN 978-1-7281-7538-6. e-ISBN 978-953-290-099-6. e-ISSN 1847-358X. Available from: doi:10.23919/SoftCOM50211.2020.9238320
6. Borysenko, O., Matsenko, S., Spolītis, S., Bobrovs, V. Development of the Fibonacci-Octal Error Detection Code for Telecommunication Systems. No: *2020 24th International Conference "Electronics": Proceedings*, Lithuania, Palanga, 15.-17. June, 2020. Piscataway: IEEE, 2020, 115.-119.lpp. ISBN 978-1-7281-5869-3. e-ISBN 978-1-7281-5868-6. Available from: doi:10.1109/IEEECONF49502.2020.9141620
7. Braunfelds, J., Spolītis, S., Poriņš, J., Bobrovs, V. Fiber Bragg Grating Sensors Integration in Fiber Optical Systems. No: *Optical Fiber*. London: IntechOpen, 2020. 1.-13.lpp. Pieejams: doi:10.5772/intechopen.94289
8. Ancāns, G., Stankevičius, E., Bobrovs, V., Ivanovs, Ģ. Estimation of Electromagnetic Compatibility between DVB-T/DVB-T2 and 4G/5G in the 700 MHz Band for Co-Channel Case. *Latvian Journal of Physics and Technical Sciences*, 2020, Vol. 57, No. 5, 30.-38.lpp. ISSN 0868-8257. Available from: doi:10.2478/lpts-2020-0025
9. Seņkāns, U., Bobrovs, V., Ivanovs, Ģ., Spolītis, S. Research of Hybrid WDM-PON Data Transmission System with Embedded ASE-Powered Stealth Channels for Steganography Applications. *Optical Fiber Technology*, 2020, Vol. 58, Article number 102300. ISSN 1068-5200. Available from: doi:10.1016/j.yofte.2020.102300
10. Udalcovs, A., Salgals, T., Zhang, L., Pang, X., Djupsjöbacka, A., Spolītis, S., Bobrovs, V., Popov, S., Ozolins, O. Optical Power Budget of 25+ Gbps IM/DD PON with Digital Signal Post-Equalization. *Applied Sciences*, 2020, Vol. 10, No. 17, Article number 6106. ISSN 2076-3417. Available from: doi:10.3390/app10176106
11. Braunfelds, J., Mūrnieks, R., Salgals, T., Brice, I., Sharashidze, T., Lyashuk, I., Ostrovskis, A., Spolītis, S., Alnis, J., Poriņš, J., Bobrovs, V. Frequency Comb Generation in WGM Microsphere Based Generators for Telecommunication Applications. *Quantum Electronics*, 2020, Vol. 50, No. 11, 1043.-1049.lpp. ISSN 1063-7818. e-ISSN 1468-4799. Available from: doi:10.1070/QEL17409
12. Anashkina, E., P. Marisova, M., V. Andrianov, A., A. Akhmedzhanov, R., Mūrnieks, R., D. Tokman, M., Skladova, L., V. Oladyshkin, I., Salgals, T., Lyashuk, I., Sorokin, A., Spolītis, S., Leuchs, G., Bobrovs, V. Microsphere-Based Optical Frequency Comb Generator for 200 GHz Spaced WDM Data Transmission System. *Photonics*, 2020, Vol. 7, No. 3, Article number 72. ISSN 2304-6732. Available from: doi:10.3390/photonics7030072
13. Borysenko, O., Matsenko, S., Novhorodtsev, A., Kobiakov, O., Spolītis, S., Bobrovs, V. Estimating the Indivisible Error Detecting Codes Based on an Average Probability Method. *Eastern-European Journal of Enterprise Technologies*, 2020, Vol. 6/9, No. 108, 25.-33.lpp. Available from: doi:10.15587/1729-4061.2020.218076
14. Salgals, T., Supe, A., Bobrovs, V., Poriņš, J., Spolītis, S. Comparison of Dispersion Compensation Techniques for Real-Time up to 160 Gbit/s DWDM C-Band Transmission. *Elektronika ir elektrotechnika = Electronics and Electrical Engineering*, 2020, Vol. 26, No. 2, 85.-93.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.26.2.25892

2019

1. Seņkāns, U., Braunfelds, J., Lyashuk, I., Poriņš, J., Spolītis, S., Bobrovs, V. Research on FBG Based Sensor Networks and Their Coexistence with Fiber Optical Transmission Systems. *Journal of Sensors*, 2019, Vol. 2019, Article number 6459387. ISSN 1687-725X. e-ISSN 1687-7268. Available from: doi:10.1155/2019/6459387
2. Putrina, J., Olonkins, S., Bobrovs, V., Poriņš, J. Investigation of EDFA Performance in DWDM Transmission Systems under Different Operating Conditions. *Latvian Journal of Physics and Technical Sciences*, 2019, Vol.56, No.2, 42.-53.lpp. ISSN 0868-8257. Available from: doi:10.2478/lpts-2019-0012
3. Matsenko, S., Borysenko, O., Spolītis, S., Bobrovs, V. Noise Immunity of the Fibonacci Counter with the Fractal Decoder Device for Telecommunication Systems. *Latvian Journal of Physics and Technical Sciences*, 2019, Vol. 56, No. 5, 12.-21.lpp. ISSN 0868-8257. Available from: doi:10.2478/lpts-2019-0027
4. Olonkins, S., Putrina, J., Bobrovs, V. Performance Comparison of Single-Pump FOPA and LRA in a 16-channel DWDM Transmission System. *Elektronika ir Elektrotechnika*, 2019, Vol. 25, No. 1, 72.-75.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.25.1.22740
5. Lizunovs, A., Stafecka, A., Bobrovs, V. Internet Access Service QoS and Signal Parameter Measurements in Urban Environment. No: *2019 23rd International Conference Electronics: Proceedings*, Lithuania, Palanga, 17.-19. June, 2019. Piscataway: IEEE, 2019, 1.-5.lpp. ISBN 978-1-7281-2210-6. e-ISBN 978-1-7281-2209-0. Available from: doi:10.1109/ELECTRONICS.2019.8765584
6. Stafecka, A., Lizunovs, A., Bobrovs, V., Gavars, P., Zariņš, Z. Quality of Service and Signal Evaluation Parameter Comparison between Different Mobile Network Operators in Urban Area. No: *2019 PhotonIcs & Electromagnetics Research Symposium - Spring (PIERS-Spring): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 3322.-3326.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017741
7. Ancāns, G., Stankevicius, E., Bobrovs, V., Osis, N. Analysis on Interference Impact of 4G/5G in 450 MHz on Digital Terrestrial Television Broadcasting. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 2173.-2179.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Fall48861.2019.9021436
8. Pavlovs, D., Bobrovs, V., Zvirbule, K., Ivanovs, Ģ. Investigation of Optical Signal Regeneration Impact on Power Efficiency of Single-line-rate and Mixed-line-rate Wavelength Division Multiplexing Systems. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 896.-901.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017644
9. Salgals, T., Ostrovskis, A., Ipatovs, A., Bobrovs, V., Spolītis, S. Hybrid ARoF-WDM PON Infrastructure for 5G Millimeter-wave Interface and Broadband Internet Service. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 2161.-2168.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. Available from: doi:10.1109/PIERS-Fall48861.2019.9021479
10. Salgals, T., Kurbatska, I., Bobrovs, V., Spolītis, S. Research of PAM-4 Modulated WDM-PON Architecture for 5G Millimeter-wave Hybrid Photonics-wireless Interface. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China,

Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 728.-734.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021846

11. Seņkāns, U., Braunfelds, J., Lyashuk, I., Poriņš, J., Spolītis, S., Haritonovs, V., Bobrovs, V. FBG Sensors Network Embedded in Spectrum-sliced WDM-PON Transmission System Operating on Single Shared Broadband Light Source. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December 2019. Piscataway: IEEE, 2019, 1632.-1639.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021628
12. Salgals, T., Kurbatska, I., Spolītis, S., Bobrovs, V., Ivanovs, Ģ. Research of PAM-4 Modulated WDM-PON Architecture for 5G Millimeter-Wave Hybrid Photonics-Wireless Interface. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 728.-734.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021846
13. Lavrinoviča, I., Supe, A., Poriņš, J. Experimental Measurement of Erbium-doped Optical Fibre Characteristics for EDFA Performance Optimization. *Latvian Journal of Physics and Technical Sciences*, 2019, Vol. 56, No. 2, 33.-41.lpp. ISSN 0868-8257. Available from: doi:10.2478/lpts-2019-0011
14. Korra, A., Salgals, T., Poriņš, J., Kažoks, E., Miho, R., Spolītis, S. Performance Analysis of Cost-Efficient High-Speed up to 32 Gbit/s WDM-PON Next-Generation Access Network with Dispersion Compensation. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 2671.-2678.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017854
15. Vagale, I., Lipenbergs, E., Bobrovs, V., Gavars, P., Ivanovs, Ģ. Network Slicing in the Scope of Net Neutrality Rules. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 1516.-1521.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017846
16. Braunfelds, J., Seņkāns, U., Lyashuk, I., Poriņš, J., Spolītis, S., Bobrovs, V. Unified Multi-channel Spectrum-sliced WDM-PON Transmission System with Embedded FBG Sensors Network. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 3327.-3333.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017809
17. Spolītis, S., Kurbatska, I., Bobrovs, V. Evaluation of the Impact of MZM Frequency Response on BER Performance of PAM-4 Modulated WDM-PON. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 1.-6.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017581
18. Salgals, T., Skladova, L., Poriņš, J., Bobrovs, V., Spolītis, S. Analog Radio-over-fiber WDM-PON Architecture for 5G Millimeter-wave Interface. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 2679.-2686.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017431
19. Kurbatska, I., R. Raddo, T., Braunfelds, J., Bobrovs, V., Cimoli, B., Rommel, S., Spolītis, S., Tafur Monroy, I. The Integration of 5G, PON and VLC Technologies for Ubiquitous Connectivity in Autonomous and Cooperative Systems. No: *Proceedings of IEEE 5G World Forum (5GWF 2019)*, Germany, Dresden, 30. Sep-2. Okt., 2019. Piscataway: IEEE, 2019, 237.-242.lpp. e-

ISBN 978-1-7281-3627-1

20. Zvirbule, K., Mūrnieks, R., Aleksejeva, M., Braunfelds, J., Lyashuk, I., Bobrovs, V. Integration of FBG Optical Sensor Network in DWDM-PON Transmission System. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 1168.-1174.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021808
21. Ancāns, A., Pētersons, E., Ancāns, G., Stetjuha, M., Ipatovs, A., Stankevicius, E. Technical and Economic Analysis of Transport Telecommunication Infrastructure. No: *Procedia Computer Science. Vol.149: ICTE in Transportation and Logistics 2018 (ICTE 2018)*, Latvia, Riga, 1.-1. November, 2018. Amsterdam: Elsevier, 2019, 206.-214.lpp. ISSN 1877-0509. Available from: doi:10.1016/j.procs.2019.01.125
22. Matsenko, S., Spolītis, S., Bobrovs, V. Integration of FEC Channel-coding Schemes Based on the Bose-Chaudhuri-Hocquenghem (BCH) Code for WDM Fiber Optical Communication Systems. No: *2019 Photonics & Electromagnetics Research Symposium - Fall (PIERS - FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 2960.-2964.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Fall48861.2019.9021780
23. Vagale, I., Lipenbergs, E., Bobrovs, V., Ivanovs, Ģ. The Analysis of the Impact of Measurement Reference Points in the Assessment of Internet Access Service Quality. No: *Progress in Electromagnetics Research Symposium - Fall (PIERS - Fall): 2019 Photonics & Electromagnetics Research Symposium*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 2972.-2977.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021747
24. Olonkins, S., Supe, A., Bobrovs, V., Prigunovs, D. Comparison of Single-pump FOPA and Raman Assisted FOPA Performance in a 16 Channel DWDM Transmission System. No: *2019 Photonics & Electromagnetics Research Symposium (PIERS FALL 2019): Proceedings*, China, Xiamen, 17.-20. December, 2019. Piscataway: IEEE, 2019, 723.-727.lpp. ISBN 978-1-7281-5305-6. e-ISBN 978-1-7281-5304-9. Available from: doi:10.1109/PIERS-Fall48861.2019.9021339
25. Olonkins, S., Putrina, J., Poriņš, J., Parts, R., Bobrovs, V. Investigation of Stimulated Raman Scattering Impact on Dual-Pump FOPA Performance in WDM Transmission Systems. No: *2019 Photonics & Electromagnetics Research Symposium - Spring (PIERS - SPRING): Proceedings*, Italy, Rome, 17.-20. June, 2019. Piscataway: IEEE, 2019, 3322.-3326.lpp. ISBN 978-1-7281-3404-8. e-ISBN 978-1-7281-3403-1. e-ISSN 1559-9450. Available from: doi:10.1109/PIERS-Spring46901.2019.9017741

2018

1. Seņkāns, U., Braunfelds, J., Spolītis, S., Bobrovs, V. Research of FBG Optical Sensors Network and Precise Peak Detection. No: *2018 Advances in Wireless and Optical Communications (RTUWO 2018): Proceedings*, Latvia, Rīga, 15.-16. November, 2018. Piscataway: IEEE, 2018, 139.-143.lpp. ISBN 978-1-5386-5559-7. e-ISBN 978-1-5386-5558-0. Available from: doi:10.1109/RTUWO.2018.8587859
2. Stafecka, A., Lizunovs, A., Bobrovs, V. Mobile LTE Network Signal and Quality of Service Parameter Evaluation from End-User Premises. No: *2018 Advances in Wireless and Optical Communications (RTUWO 2018): Proceedings*, Latvia, Riga, 15.-16. November, 2018. Piscataway: IEEE, 2018, 209.-212.lpp. ISBN 978-1-5386-5559-7. e-ISBN 978-1-5386-5558-0. Available from: doi:10.1109/RTUWO.2018.8587890
3. Ancāns, G., Bobrovs, V. Spectrum Usage for 5G Mobile Communication Systems and Electromagnetic Compatibility with Existent Technologies. No: *Broadband Communications*

Networks - Recent Advances and Lessons from Practice. A.Haidine, A.Aqqal red. London: IntechOpen, 2018. 27.-41.lpp. ISBN 978-1-78923-742-9. e-ISBN 978-1-78923-743-6. Available from: doi:10.5772/intechopen.72431

4. Spolītis, S., Kurbatska, I., Bobrovs, V. Considering of PAM-4, DB, NRZ and RZ for Implementation in Next-Generation PONs. No: *2018 26th International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2018): Proceedings*, Croatia, Split, 13.-15. September 2018. Piscataway: IEEE, 2018, 70.-75.lpp. ISBN 978-1-5386-6770-5. e-ISBN 978-9-5329-0087-3. Available from: doi:10.23919/SOFTCOM.2018.8555736
5. Spolītis, S., Kurbatska, I., Bobrovs, V. Evaluation of the Channel Spacing and Transceiver Bandwidth for PAM-4 Modulated WDM-PON. In: *2018 Advances in Wireless and Optical Communications (RTUWO 2018): Proceedings*, Latvia, Riga, 15-16 November, 2018. Piscataway: IEEE, 2018, pp.148-153. ISBN 978-1-5386-5559-7. e-ISBN 978-1-5386-5558-0. Available from: doi:10.1109/RTUWO.2018.8587787
6. Lavrinoviča, I., Supe, A., Udaļcovs, A., Ozoliņš, O., Popov, S., Poriņš, J. Exploration of Optical Amplifiers Based on Erbium (Er3+) and Ytterbium (Yb3+) Doped Fiber Segments and Its Emerging Applications. No: *2018 Progress in Electromagnetics Research Symposium (PIERS-Toyama 2018): Proceedings*, Japan, Toyama, 1.-4. Augusts, 2018. Piscataway: IEEE, 2018, 237.-240.lpp. ISBN 978-1-5386-5455-2. e-ISBN 978-4-8855-2316-8. Available from: doi:10.23919/PIERS.2018.8598244
7. Smirnova, I., Lipenbergs, E., Bobrovs, V. Mathematical Algorithm for Processing Measurement Results of Internet Access Service in the Scope of Net Neutrality. *Latvian Journal of Physics and Technical Sciences*, 2018, Vol.55, No.3, 63.-69.lpp. ISSN 0868-8257. Available from: doi:10.2478/lpts-2018-0022

2017

1. Pavlovs, D., Bobrovs, V., Parfjonovs, M., Alševska, A., Ivanovs, Ģ. Evaluation of Signal Regeneration Impact on the Power Efficiency of Long-Haul DWDM Systems. *Latvian Journal of Physics and Technical Sciences*, 2017, Vol.54, Iss.5, 68.-77.lpp. e-ISSN 0868-8257. Available from: doi:10.1515/lpts-2017-0035
2. Ciekurs, A., Poriņš, J., Kločana, M. Assessment of Lifetime of the Fiber Optic Infrastructure Based on Attenuation Measurements. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016)*, Latvia, Riga, 3.-4. November, 2016. Piscataway: IEEE, 2017, 70.-74.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821858
3. Grūnvalds, R., Ciekurs, A., Poriņš, J., Supe, A. Evaluation of Fibre Lifetime in Optical Ground Wire Transmission Lines. *Latvian Journal of Physics and Technical Sciences*, 2017, Vol.54, No.3, 40.-49.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2017-0019
4. Nazarovs, V., Jeļinskis, J., Poriņš, J., Lavrinoviča, I., Supe, A., Aišpurs, V. Architecture and Research of M2M Wireless Mesh Networks. No: *2017 Progress in Electromagnetics Research Symposium - Spring (PIERS 2017): Proceedings*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 2500.-2503.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. ISSN 1559-9450. Available from: doi:10.1109/PIERS.2017.8262172
5. Ancāns, G., Stafecka, A., Bobrovs, V., Ancāns, A., Čaiko, J. Analysis of Characteristics and Requirements for 5G Mobile Communication Systems. *Latvian Journal of Physics and Technical Sciences*, 2017, Vol.54, Iss.4, 69.-78.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2017-0028
6. Ancāns, G., Bobrovs, V., Ancāns, A., Kalibatiene, D. Spectrum Considerations for 5G Mobile Communication Systems. *Procedia Computer Science*, 2017, Vol. 104, 509.-516.lpp. ISSN 1877-0509. Available from: doi:10.1016/j.procs.2017.01.166

7. Kurbatska, I., Alševska, A., Ģēģere, L., Bobrovs, V. Investigation of Influence of Mixed Configurations on Performance of WDM-PON. *Elektronika ir elektrotechnika = Electronics and Electrical Engineering*, 2017, Vol.23, No.2, 74.-78.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.23.2.18003
8. Olonkins, S., Bičkovs, V., Salgals, T., Bobrovs, V., Ivanovs, Ģ. Investigation of Dual-Pump FOPA Performance in a 4-Channel 40 Gbps WDM Transmission System. *Elektronika ir elektrotechnika = Electronics and Electrical Engineering*, 2017, Vol. 23, No. 6, 85.-89.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.23.6.19699
9. Alševska, A., Dilendorfs, V., Spolītis, S., Bobrovs, V. Comparison of Chromatic Dispersion Compensation Method Efficiency for 10 Gbit/S RZ-OOK and NRZ-OOK WDM-Pon Transmission Systems. *Latvian Journal of Physics and Technical Sciences*, 2017, Vol.54, No.6, 65.-75.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2017-0042
10. Salgals, T., Spolītis, S., Olonkins, S., Bobrovs, V. Investigation of 4-PAM Modulation Format for Use in WDM-PON Optical Access Systems. No: *Progress in Electromagnetics Research Symposium (PIERS 2017): Proceedings*, Russia, St. Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 2450.-2454.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. ISSN 1559-9450. Available from: doi:10.1109/PIERS.2017.8262162
11. Skripņiks, D., Šarkovskis, S., Jeršovs, A., Grabs, E. Impulse Response Approximation of Digital Finite Impulse Response Filter with Delay Line Units. *Automatic Control and Computer Sciences*, 2017, Vol.51, No.4, 279.-284.lpp. ISSN 0146-4116. e-ISSN 1558-108X. Available from: doi:10.3103/S0146411617040071
12. Šarkovskis, S., Jeršovs, A., Kolosovs, D., Grabs, E. Encoder Improvement for Simple Amplitude Fully Parallel Classifiers Based on Gray Codes. No: *Procedia Engineering*, Latvia, Riga, 19.-22. October, 2016. Amsterdam, Netherlands: Elsevier Ltd., 2017, 604.-614.lpp. ISSN 1877-7058. Available from: doi:10.1016/j.proeng.2017.01.119
13. Pavlovs, D., Parts, R., Dzhamanshalov, M., Bobrovs, V. Comparison of Power Efficiency and Signal Regeneration Impact in the SLR DWDM Transmission Systems with Different Spectral Band. No: *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 1122.-1127.lpp. ISBN 978-1-5386-1212-5. e-ISBN 978-1-5386-1211-8. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS-FALL.2017.8293302
14. Pavlovs, D., Bobrovs, V., Ivanovs, Ģ., Gavars, P. The Impact of Signal Regeneration on the DWDM System's Power Efficiency using 10 Gbps NRZ-OOK. No: *2017 Progress in Electromagnetics Research Symposium - Spring (PIERS 2017): Proceedings*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 2990.-2994.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2017.8262268
15. Ancāns, G., Stankevicius, E., Bobrovs, V. Investigation of Electromagnetic Compatibility between DVB-T/T2 and LTE 700 for Co-channel Case. No: *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 875.-878.lpp. ISBN 978-1-5386-1212-5. e-ISBN 978-1-5386-1211-8. Available from: doi:10.1109/PIERS-FALL.2017.8293257
16. Bobrovs, V., Olonkins, S., Spolītis, S., Poriņš, J., Ivanovs, Ģ. Evaluation of Parametric and Hybrid Amplifier Applications in WDM Transmission Systems. No: *Optical Fiber and Wireless Communications*. R.Roka red. Rijeka: InTech, 2017. 181.-210.lpp. ISBN 978-953-51-3275-2. e-ISBN 978-953-51-3276-9. Available from: doi:10.5772/67607
17. Spolītis, S., Kurbatska, I., Bobrovs, V. Comparison of C-Band and L-Band WDM-PON Systems Performance with PAM-4 Modulation Format. No: *2017 International Workshop on Fiber Optics in Access Network (FOAN 2017)*, Germany, Munich, 6.-8. November, 2017. Piscataway: IEEE, 2017, 25.-30.lpp. ISBN 978-1-5386-2414-2. e-ISBN 978-1-5386-2413-5. e-ISSN 2378-8488.

Available from: doi:10.1109/FOAN.2017.8215251

18. Putrina, J., Olonkins, S., Bobrovs, V., Ivanovs, Ģ. Comparison of Discrete and Distributed In-Line Raman Amplifiers in a 16 Channel DWDM Transmission System. No: *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 236.-241.lpp. ISBN 978-1-5386-1212-5. e-ISBN 978-1-5386-1211-8. Available from: doi:10.1109/PIERS-FALL.2017.8293141
19. Hasanuzzaman, K., Spolītis, S., Salgals, T., Braunfelds, J., Morales, A., González, L., Rommel, S., Puerta, R., Asensio, P., Bobrovs, V., Iezekiel, S., Tafur Monroy, I. Performance Enhancement of Multi-Core Fiber Transmission Using Real-Time FPGA Based Pre-Emphasis. No: *Proceedings of Asia Communications and Photonics Conference (ACP 2017)*, China, Guangzhou, Guangdong, 10.-13. November, 2017. Guangzhou: IEEE Photonics Society, 2017, 1.-3.lpp. ISBN 978-1-943580-34-7. Available from: doi:10.1364/ACPC.2017.M2H.1
20. Kurbatska, I., Bobrovs, V., Gavars, P., Ģēģere, L. Evaluation of the Impact of Parameters of Transmission System on the Performance of WDM-PON. No: *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 1370.-1376.lpp. ISBN 978-1-5386-1212-5. e-ISBN 978-1-5386-1211-8. Available from: doi:10.1109/PIERS-FALL.2017.8293344
21. Seņkāns, U., Spolītis, S., Bobrovs, V. Evaluation and Research of FBG Optical Temperature Sensors Network. No: *2017 Advances in Wireless and Optical Communications (RTUWO 2017): Proceedings*, Latvia, Riga, 2.-3. November, 2017. Piscataway: IEEE, 2017, 79.-89.lpp. ISBN 978-1-5386-0586-8. e-ISBN 978-1-5386-0585-1. Available from: doi:10.1109/RTUWO.2017.8228509
22. Spolītis, S., Lyashuk, I., Bobrovs, V. Design and Performance Evaluation of FBG-based Temperature Sensors Network. No: *Progress in Electromagnetics Research Symposium (PIERS 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 2673.-2678.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS-FALL.2017.8293590
23. Dilendorfs, V., Parfjonovs, M., Alševska, A., Spolītis, S., Bobrovs, V. Influence of Dispersion Slope Compensation on 40 Gbit/s WDM-PON Transmission System Performance with G.652 and G.655 Optical Fibers. No: *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL 2017): Proceedings*, Singapore, Singapore, 19.-22. November, 2017. Piscataway: IEEE, 2017, 598.-604.lpp. ISBN 978-1-5386-1212-5. e-ISBN 978-1-5386-1211-8. Available from: doi:10.1109/PIERS-FALL.2017.8293207
24. Allabouche, K., Bobrovs, V. Multiband Rectangular Dielectric Resonator Antenna for 5G Applications. No: *2017 International Conference on Wireless Technologies, Embedded and Intelligent Systems (WITS)*, Maroca, Fez, 26.-28. May, 2017. Piscataway: IEEE, 2017, 1.-6.lpp. ISBN 978-1-5090-6682-7. e-ISBN 978-1-5090-6681-0. Available from: doi:10.1109/WITS.2017.7934637
25. Putrina, J., Olonkins, S., Bobrovs, V. Investigation of Amplification Span Length Impact on the Quality of the Signal in WDM Transmission Systems with Erbium-doped Fiber Amplifiers. No: *2017 Progress in Electromagnetics Research Symposium (PIERS 2017): Proceedings*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 1753.-1759.lpp. ISBN 978-1-934142-28-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. Available from: doi:10.1109/PIERS.2017.8262033
26. Putrina, J., Olonkins, S., Bobrovs, V. Investigation of EDFA Positioning Impact on the Quality of the Amplified Signal in DWDM Transmission Systems. No: *2017 Electronics: Proceedings of the Conference*, Lithuania, Palanga, 19.-21. June, 2017. Piscataway: IEEE, 2017, 66.-70.lpp. ISBN 978-1-5386-0395-6. e-ISBN 978-1-5386-0394-9. Available from:

doi:10.1109/ELECTRONICS.2017.7995230

27. Ancāns, G., Sharashidze, T., Bobrovs, V. Electromagnetic Compatibility Assessment of LTE 700 Networks for Co-channel Case. No: *Progress in Electromagnetics Research Symposium (PIERS 2017)*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 2511.-2514.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. Available from: doi:10.1109/PIERS.2017.8262175
28. Stafecka, A., Lipenbergs, E., Bobrovs, V., Sharashidze, T. Quality of Service Methodology for the Development of Internet Broadband Infrastructure of Mobile Access Networks. No: *2017 Electronics: Proceedings of the Conference*, Lithuania, Palanga, 19.-21. June, 2017. Piscataway: IEEE, 2017, 61.-65.lpp. ISBN 978-1-5386-0395-6. e-ISBN 978-1-5386-0394-9. Available from: doi:10.1109/ELECTRONICS.2017.7995229
29. Kurbatska, I., Bobrovs, V., Alševska, A., Ljashuk, I., Ģēģere, L. Spectral Effective Solutions for Mixed Line Rate WDM-PON Systems. No: *2017 Progress in Electromagnetics Research Symposium - Spring (PIERS 2017): Proceedings*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 1771.-1777.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. Available from: doi:10.1109/PIERS.2017.8262037
30. Olonkins, S., Stankunovs, I., Pilāts, D., Bobrovs, V. Suppression of CC-FWM Inter-Channel Crosstalk Using Unequal Channel Spacing in an 8-channel WDM Transmission System with Parametric Amplification. No: *2017 Progress in Electromagnetics Research Symposium - Spring (PIERS 2017): Proceedings*, Russia, Saint Petersburg, 22.-25. May, 2017. Piscataway: IEEE, 2017, 1747.-1747.lpp. ISBN 978-1-5090-6270-6. e-ISBN 978-1-5090-6269-0. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2017.8262032

2016

1. Bogdanovs, N., Grabs, E., Pētersons, E. Software Implementation of Real-time Discrete Wavelet Transform Algorithm with Filter Banks. *International Journal of Information Systems in the Service Sector*, 2016, Vol.8, No.2, 70.-86.lpp. ISSN 1935-5688. e-ISSN 1935-5696. Available from: doi:10.4018/IJISSS.2016040106
2. Kalibatiene, D., Vasilecas, O., Bobrovs, V. Resource Modelling for the Rule- and Context-Based Dynamic Business Process Simulation. No: *CompSysTech '16: Proceedings of the 17th International Conference on Computer Systems and Technologies 2016*, Italy, Palermo, 23.-24. June, 2016. New York: Association for Computing Machinery, 2016, 17.-24.lpp. ISBN 978-145034182-0. Available from: doi:10.1145/2983468.2983518
3. Kurbatska, I., Alševska, A., Ģēģere, L., Bobrovs, V. Comparison of Modulation Formats for Use in the Next Generation Passive Optical Networks. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3783.-3787.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. Available from: doi:10.1109/PIERS.2016.7735425
4. Pavlovs, D., Bobrovs, V. Relationship between Spectral Efficiency and Energy Efficiency in 10 Gbps NRZ-OOK, 40 Gbps NRZ-DPSK and 100 Gbps DP-QPSK WDM Transmission Systems. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 1434.-1438.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. Available from: doi:10.1109/PIERS.2016.7734673
5. Lavrinoviča, I., Poriņš, J., Supe, A. Evaluation of Effective Area of Ytterbium Doped Optical Fiber. No: *12th International Young Scientist Conference "Developments in Optics and Communications 2016": Book of Abstracts*, Latvia, Riga, 21.-23. marts, 2016. Riga: Publishing House of University of Latvia, 2016, 49.-49.lpp. ISBN 78-9934-556-02-9. e-ISBN 78-9934-556-03-6
6. Shakya, S., Supe, A., Lavrinoviča, I., Spolītis, S., Poriņš, J. Different Optical Fiber Nonlinear

Coefficient Experimental Measurements. No: *2016 International Workshop on Fiber Optics in Access Network (FOAN 2016): Proceedings*, Portugal, Lisbon, 18.-20. October, 2016. Piscataway: IEEE, 2016, 1.-4.lpp. e-ISSN 2378-8488. Available from: doi:10.1109/FOAN.2016.7764544

7. Lavrinoviča, I., Poriņš, J. An Improvement of EDFA Efficiency by using Ytterbium Co-Doped Optical Fibers. No: *2016 IEEE International Black Sea Conference on Communications and Networking (BlackSeaCom 2016): Proceedings*, Bulgaria, Varna, 6.-9. June, 2016. Piscataway: IEEE, 2016, 1.-3.lpp. ISBN 978-1-5090-1926-7. e-ISBN 978-1-5090-1925-0. Available from: doi:10.1109/BlackSeaCom.2016.7901584
8. Lavrinoviča, I., Poriņš, J., Brūklītis, E., Supe, A. Evaluation of Effective Area and Nonlinearity Coefficient of Erbium-Ytterbium Doped Optical Fibers. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3438.-3444.lpp. ISBN 78-1-934142-30-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735338
9. Maharjan, R., Lavrinoviča, I., Supe, A., Poriņš, J. Minimization of FWM Effect in Nonlinear Optical Fiber using Variable Channel Spacing Technique. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016): Proceedings*, Latvia, Riga, 3.-4. November, 2016. Piscataway: IEEE, 2016, 1.-4.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821844
10. Putrina, J., Olonkins, S., Bobrovs, V. Investigation of In-line EDFA Performance Dependence on Channel Spacing in WDM Transmission Systems. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016): Proceedings*, Latvia, Riga, 3.-4. November 2016. Piscataway: IEEE, 2016, 17.-21.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821848
11. Ancāns, G., Stankevicius, E., Bobrovs, V., Ancāns, A. Analysis on Interference Impact of Wi-Fi on Digital Terrestrial Television Broadcasting. No: *WTS 2016: Wireless Telecommunications Symposium. Global Wireless Communications: Europe and Beyond*, United Kingdom, London, 18.-20. April, 2016. London: 2016, 1.-5.lpp.
12. Ancāns, G., Stankevicius, E., Bobrovs, V. Evaluation of LTE 700 and DVB-T and DVB-T2 Electromagnetic Compatibility for Co-channel Case. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 4253.-4257.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. Available from: doi:10.1109/PIERS.2016.7735596
13. Spolītis, S., Bobrovs, V., Parts, R., Ivanovs, Ģ. Extended Reach 32-Channel Dense Spectrum-Sliced Optical Access System. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3764.-3767.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735421
14. Lipenbergs, E., Bobrovs, V., Ivanovs, Ģ. Quality of Service Measurements References Investigation for the Mobile Internet Services in the Context of Net Neutrality Framework. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 4248.-4252.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. Available from: doi:10.1109/PIERS.2016.7735595
15. Olonkins, S., Bobrovs, V., Ivanovs, Ģ., Parts, R., Gavars, P. Demonstration of a Dual-Pump FOPA Based 48 Channel Multicarrier Optical Source for WDM Transmission Systems. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3768.-3772.lpp. ISBN 978-1-934142-28-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. Available from: doi:10.1109/PIERS.2016.7735422

16. Olonkins, S., Stankunovs, I., Alševska, A., Ģēģere, L., Bobrovs, V. Investigation of in-line Distributed Raman Amplifiers with Co and Counter-propagating Pumping Schemes. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3773.-3777.lpp. ISBN 978-1-934142-28-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735423
17. Olonkins, S., Bobrovs, V., Pilāts, D., Poriņš, J. Comparison of EDFA and LRA Preamplifier Performance in WDM Transmission Systems. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3778.-3782.lpp. ISBN 978-1-934142-28-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735424
18. Dilendorfs, V., Spolītis, S., Bobrovs, V. Effectiveness Evaluation of Dispersion Compensation Methods for Fiber-optical Transmission Systems. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3759.-3763.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735420
19. Kurbatska, I., Spolītis, S., Ivanovs, Ģ., Bobrovs, V. Investigation on Optimal Transmission Parameters for Different Modulation Formats in 10 Gbit/s WDM-PON Systems. No: 2016 International Workshop on Fiber Optics in Access Network (FOAN 2016): Proceedings, Portugal, Lisbon, 18.-20. October, 2016. Piscataway: IEEE, 2016, 24.-28.lpp. ISBN 978-1-5090-3320-1. e-ISBN 978-1-5090-3319-5. e-ISSN 2378-8488. Available from: doi:10.1109/FOAN.2016.7764542
20. Kurbatska, I., Spolītis, S., Bobrovs, V., Alševska, A., Ivanovs, Ģ. Performance Comparison of Modulation Formats for 10 Gbit/s WDM-PON Systems. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016): Proceedings*, Latvia, Riga, 3.-4. November, 2016. Piscataway: IEEE, 2016, 51.-54.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821854
21. Mehmeri, V., Jose Vegas Olmos, J., Tafur Monroy, I., Spolītis, S., Bobrovs, V. Architecture and Evaluation of Software-Defined Optical Switching Matrix for Hybrid Data Centers. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016): Proceedings*, Latvia, Riga, 3.-4. November, 2016. Piscataway: IEEE, 2016, 55.-58.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821855
22. Putrina, J., Bobrovs, V. Evaluation of Erbium Doped Fiber Amplifier Application in Fiber Optics Transmission Systems. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3796.-3802.lpp. ISBN 978-1-934142-28-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. Available from: doi:10.1109/PIERS.2016.7735428
23. Bičkovs, V., Bobrovs, V. Performance Evaluation of a 40 Gbps WDM Transmission System with a Single-pump Raman Amplifier. No: *2016 Progress in Electromagnetics Research Symposium (PIERS 2016 Shanghai): Proceedings*, China, Shanghai, 8.-11. Augusts, 2016. Piscataway: IEEE, 2016, 3792.-3795.lpp. ISBN 978-1-5090-6094-8. e-ISBN 978-1-5090-6093-1. ISSN 1559-9450. e-ISSN 1559-8985. Available from: doi:10.1109/PIERS.2016.7735427
24. Pavlovs, D., Grinčišins, A., Bobrovs, V., Gavars, P., Ivanovs, Ģ. Research of 10 Gbps NRZ-OOK Signal Spectral and Energy Efficiency. No: *ELECTRONICS 2016 Proceedings*, Lithuania, Palanga, 13.-15. June, 2016. Kaunas: Kaunas University of Technology, 2016, 25.-29.lpp. ISSN 2424-5623
25. Ancāns, G., Bobrovs, V. Evaluation of LTE Broadcast Use in the 470-694 MHz Band. No: *Riga Technical University 57th International Scientific Conference*, Latvia, Riga, 14.-18. October, 2016. Riga: RTU Publishing, 2016, 137.-137.lpp. ISBN 978-9934-10-862-4

26. Bičkovs, V., Olonkins, S., Bobrovs, V. Raman Pre-Amplifier Performance Comparison in Two 320 Gbps Transmission Systems. No: *2016 Advances in Wireless and Optical Communications (RTUWO 2016): Proceedings*, Latvia, Riga, 2.-4. November 2016. Piscataway: IEEE, 2016, 13.-16.lpp. ISBN 978-1-5090-1536-8. e-ISBN 978-1-5090-1535-1. Available from: doi:10.1109/RTUWO.2016.7821847
27. Olonkins, S., Bobrovs, V., Ivanovs, Ģ. FOPA Pump Phase Modulation and Polarization Impact on Generation of Idler Components. *Elektronika ir elektrotechnika = Electronics and Electrical Engineering*, 2016, Vol. 77, No. 4, 77.-81.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.22.4.15924
28. Ancāns, G., Stankevicius, E., Bobrovs, V., Ivanovs, Ģ. Evaluation of LTE and Aeronautical Radionavigation Service Electromagnetic Compatibility in 694–790 MHz Frequency Band. *Elektronika ir elektrotechnika*, 2016, Vol.22, No.6, 99.-103.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eie.22.6.17231
29. Bobrovs, V., Udaļcovs, A. Energy Efficiency in WDM Fiber-Optical Links Considering OADM/OXC Nodes. *Optics Communications*, 2016, Vol.359, 102.-108.lpp. ISSN 0030-4018. Available from: doi:10.1016/j.optcom.2015.09.061
30. Kurbatska, I., Bobrovs, V., Spolītis, S., Gavars, P., Ivanovs, Ģ., Parts, R. Investigation on Maximum Available Reach for Different Modulation Formats in WDM-PON Systems. *Latvian Journal of Physics and Technical Sciences*, 2016, Nr. 4, 66.-75.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2016-0030
31. Kalibatiene, D., Bobrovs, V., Vasilecas, O., Savickas, T., Vysockis, T. A New Approach on Rule and Context Based Dynamic Business Process Simulation. *Baltic Journal Modern Computing*, 2016, Vol.12, No.1, 408.-419.lpp. ISSN 2255-8942. e-ISSN 2255-8950
32. Ancāns, G., Stankevicius, E., Bobrovs, V., Ancāns, A. Analysis on Interference Impact of Wi-Fi on Digital Terrestrial Television Broadcasting. *International Journal of Interdisciplinary Telecommunications and Networking (IJITN)*, 2016, Vol.8, Iss.1, 35.-44.lpp. ISSN 1941-8663. e-ISSN 1941-8671. Available from: doi:10.4018/IJITN.2016010104
33. Lipenbergs, E., Bobrovs, V., Ivanovs, Ģ. Investigation of Service Quality of Measurement Reference Points for the Internet Services on Mobile Networks. *Latvian Journal of Physics and Technical Sciences*, 2016, Vol.53, No.5, 64.-73.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2016-0037

2015

1. Ozoliņš, O., Trifonovs, I., Parts, R., Bobrovs, V. All-Optical NRZ-to-PRZ Format Conversion Limitations Using Notch Filters. Elektronika ir elektrotechnika, 2015, Vol.21, No.1, 64.-69.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eee.21.1.9807
2. Ancāns, G., Bobrovs, V., Ivanovs, Ģ. Frequency Arrangement for 700 MHz Band. *Latvian Journal of Physics and Technical Sciences*, 2015, Vol.52, Iss.1, 52.-67.lpp. ISSN 0868-8257. Available from: doi:10.1515/lpts-2015-0005
3. Ancāns, G., Stankevicius, E., Bobrovs, V. Assessment of DVB-T Compatibility with LTE in Adjacent Channels in 700 MHz Band. *Elektronika ir elektrotechnika = Electronics and Electrical Engineering*, 2015, Vol.21, No.4, 73.-77.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eee.21.4.12788
4. Grabs, E., Pētersons, E. Hurst Parameter Estimation by Wavelet Transformation and a Filter Bank for SelfSimilar Traffic. *Automatic Control and Computer Sciences*, 2015, Vol.49, No.5, 286.-292.lpp. ISSN 0146-4116. e-ISSN 1558-108X. Available from: doi:10.3103/S0146411615050041
5. Lavrinoviča, I., Poriņš, J., Ivanovs, Ģ. Estimation of EDFA Performance in 40 Gbit/s 8 Channel DWDM Transmission System. No: *Progress in Electromagnetics Research Symposium (PIERS 2015): Proceedings*, Czech Republic, Prague, 6.-9. July, 2015. Prague: The Electromagnetics

Academy, 2015, 502.-505.lpp. ISBN 978-1-934142-28-8. ISSN 1559-9450
6. Lavrinoviča, I., Poriņš, J. Noise Figure Analysis of EDFA with Different Pumping Configurations in 40 Gbit/s 8 Channel DWDM Transmission System. No: *2015 Advances in Wireless and Optical Communications (RTUWO): Proceedings*, Latvija, Riga, 5.-6. novembris, 2015. Piscataway: IEEE, 2015, 34.-37.lpp. ISBN 978-1-4673-7430-9. e-ISBN 978-1-4673-7431-6. Pieejams: doi:10.1109/RTUWO.2015.7365714
7. Bajpayee, P., Poriņš, J., Supe, A. Influence of Optical Fiber Dispersion on Mamyshev Type Regenerator Performance. No: *Progress in Electromagnetics Research Symposium Proceedings*, Čehija, Prague, 6.-9. jūlijs, 2015. Cambridge: The Electromagnetics Academy, 2015, 489.-492.lpp. ISBN 978-1-934142-30-1. ISSN 1559-9450
8. Lavrinoviča, I., Poriņš, J. Investigation of EDFA Performance in 8 Channel WDM Transmission System. No: *11th International Young Scientist Conference "Developments in Optics and Communications 2015": Book of Abstracts / ed. J.Zaharans, M.Bruvelis*, Latvija, Riga, 8.-10. aprīlis, 2015. Riga: University of Latvia, 2015, 59.-59.lpp. ISBN 9789934517808. e-ISBN 9789934517815
9. Lavrinoviča, I., Poriņš, J., Ivanovs, Ģ. Estimation of EDFA Performance in 40 Gbit/s 8 Channel DWDM Transmission System. No: *Progress in Electromagnetics Research Symposium (PIERS 2015): Book of Abstracts*, Čehija, Prague, 6.-9. jūlijs, 2015. Prague: PIERS, 2015, 576.-576.lpp. ISBN 978-1-934142-29-5. ISSN 1559-9450
10. Čulkovs, D., Grabs, E., Klūga, A. Temperature Control of Drying Chambers with Fuzzy Logic Algorithm for Common Microcontroller Systems. *Journal of Energy and Power Sources*, 2015, Vol.2, No.4, 152.-157.lpp. ISSN 2333-9136. e-ISSN 2333-9144
11. Bobrovs, V., Ozoliņš, O. Theoretical Study of All-optical RZ-OOK to NRZ-OOK Format Conversion in Uniform FBG for Mixed Line-Rate DWDM Systems. *Chinese Optics Letters*, 2015, Vol.13, Iss.6, 1.-5.lpp. ISSN 1671-7694. Pieejams: doi:10.3788/COL201513.060603
12. Ancāns, G., Stankevicius, E., Bobrovs, V., Paulikas, S. Evaluation of LTE 700 and DVB-T Electromagnetic Compatibility in Adjacent Frequency Bands. No: *Progress in Electromagnetics Research Symposium (PIERS 2015): Proceedings*, Čehija, Prague, 6.-9. jūlijs, 2015. Cambridge: The Electromagnetics Academy, 2015, 585.-589.lpp. ISBN 978-1-934142-30-1. ISSN 1559-9450
13. Olonkins, S., Lyashuk, I., Bobrovs, V., Ivanovs, Ģ. Equalization of EDFA Gain Spectrum and Increase of OSNK through Introducing a Hybrid Raman-EDFA Solution. No: *Progress in Electromagnetics Research Symposium (PIERS 2015): Proceedings*, Čehija, Prague, 6.-9. jūlijs, 2015. Prague: The Electromagnetics Academy, 2015, 600.-603.lpp. ISBN 978-1-934142-28-8. ISSN 1559-9450
14. Ancāns, G., Bobrovs, V. Assessment of Spectrum Considerations for 5G Mobile Broadband Communication Systems. No: *Riga Technical University 56th International Scientific Conference*, Latvija, Riga, 14.-16. oktobris, 2015. Riga: RTU Publishing, 2015, 159.-159.lpp. ISBN 978-9934-10-750-4
15. Spolītis, S., Wagner, C., Bobrovs, V., Olmos, J., Tafur Monroy, I. Towards Bandwidth Scalable Transceiver Technology for Optical Metro-Access Networks. No: *2015 Advances in Wireless and Optical Communications (RTUWO): Proceedings*, Latvija, Rīga, 5.-6. novembris, 2015. Piscataway: IEEE, 2015, 94.-97.lpp. ISBN 978-1-4673-7430-9. e-ISBN 978-1-4673-7431-6. Pieejams: doi:10.1109/RTUWO.2015.7365727
16. Andrus, B., Olmos, J., Mehmeri, V., Tafur Monroy, I., Spolītis, S., Bobrovs, V. SDN Data Center Performance Evaluation of Torus and Hypercube Interconnecting Schemes. No: *Proceedings of Advances in Wireless and Optical Communications*, Latvija, Rīga, 5.-6. novembris, 2015. Rīga: IEEE, 2015, 1.-3.lpp. e-ISBN 978-1-4673-7431-6
17. Wagner, C., Spolītis, S., Olmos, J., Bobrovs, V., Tafur Monroy, I. Re-use of Low Bandwidth Equipment for High Bit Rate Transmission Using Signal Slicing Technique. No: *Asia*

Communications and Photonics Conference 2015, Honkonga, Hong Kong, 19.-23. November, 2015. [S.l.]: Optical Society of America, 2015, 1.-3.lpp. ISBN 978-1-943580-06-4. Available from: doi:10.1364/ACPC.2015.ASu5E.3

18. Spolītis, S., Ģēģere, L., Alševska, A., Trifonovs, I., Poriņš, J., Bobrovs, V. Optical WDM-PON Access System with Shared Light Source. No: *Progress in Electromagnetics Research Symposium (PIERS 2015): Proceedings*, Czech Republic, Prague, 6.-9. July, 2015. Prague: The Electromagnetics Academy, 2015, 497.-501.lpp. ISBN 78-1-934142-30-1. ISSN 1559-9450
19. Spolītis, S., Wagner, C., Bobrovs, V., Vegas Olmos, J., Tafur Monroy, I. Transparent Sliceable Transceiver Technology for Optical Metro-Access Networks. No: *1st International IEEE Conference on Advances in Wireless and Optical Communications 2015*, Latvia, Riga, 5.-6. November, 2015. Riga: RTU Press, 2015, 105.-117.lpp. ISBN 978-9934-10-758-0

2014

1. Ancāns, G., Bobrovs, V., Ivanovs, Ģ. Evaluation of 700 MHz Band Use for Land Mobile Service. No: *Riga Technical University 55th International Scientific Conference*, Latvia, Riga, 17.-17. October, 2014. Riga: RTU Publishing, 2014, 22.-22.lpp. ISBN 978-9934-10-607-1
2. Udaļcovs, A., Bobrovs, V. Transponder Impact on Power Efficiency in WDM-Links Based on 10-40-100 Gbps Mixed-Line Rates. No: *8th International Conference "Advanced Optical Materials and Devices": Programme and Abstracts*, Latvia, Riga, 25.-27. August, 2014. Riga: Institute of Atomic Physics and Spectroscopy, 2014, 62.-62.lpp. ISBN 978-9934-517-58-7. e-ISBN 978-9934-517-59-4
3. Olonkins, S., Bobrovs, V. Implementation of Fiber Optical Parametric Amplifier for Distinguishing of Polarizatrion Multiplexed Signals in Optical Transmission Systems. No: *8th International Conference "Advanced Optical Materials and Devices": Programme and Abstracts*, Latvia, Riga, 25.-27. August, 2014. Riga: Institute of Atomic Physics and Spectroscopy, 2014, 27.-28.lpp. ISBN 978-9934-517-58-7. e-ISBN 978-9934-517-59-4
4. Bobrovs, V., Gavars, P., Ivanovs, Ģ., Trifonovs, I., Udaļcovs, A. Transponder Impact on Power and Spectral Efficiencies in WDM Links Based on 10-40-100 Gbps Mixed-Line Rates. No: *Progress in Electromagnetic Research Symposium (PIERS 2014): Abstracts*, China, Guangzhou, 25.-28. Augusts, 2014. Guangzhou: The Electromagnetics Academy, 2014, 1367.-1367.lpp. ISBN 978-1-934142-27-1. ISSN 1559-9450
5. Olonkins, S., Lyashuk, I., Poriņš, J. Demonstration of Polarization Muiltiplexed Signals Division Using a Fiber Optical Parametric Amplifier. No: *Progress in Electromagnetic Research Symposium (PIERS 2014): Proceedings*, China, Guangzhou, 25.-28. Augusts, 2014. Guangzhou: The Electromagnetics Academy, 2014, 1669.-1673.lpp. ISBN 978-1-934142-28-8. ISSN 1559-9450
6. Ozoliņš, O., Parts, R., Bobrovs, V. Impact of Cascaded MRRs on All-Optical Clock Recovery from 40 Gbit/s RZ-OOK Signal. No: *9th IEEE, IET International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP14): Proceedings*, England, Manchester, 23.-25. July, 2014. Manchester: Manchester Metropolitan University, 2014, 1.-4.lpp.
7. Bobrovs, V., Gavars, P., Ivanovs, Ģ., Trifonovs, I., Udaļcovs, A. Transponder Impact on Power and Spectral Efficiencies in WDM Links Based on 10-40-100 Gbps Mixed-Line Rates. No: *Progress in Electromagnetic Research Symposium (PIERS 2014): Proceedings*, China, Guangzhou, 25.-28. Augusts, 2014. Guangzhou: The Electromagnetics Academy, 2014, 1664.-1668.lpp. ISBN 978-1-934142-28-8. ISSN 1559-9450
8. Spolītis, S., Olonkins, S., Poriņš, J. Realization of Dense Bidirectional Spectrum Sliced WDM-PON Access System No: *9th International Symposium on Communications Systems, Networks and Digital Signal Processing (CSNDSP 2014): Conference Proceedings*, England, Manchester, 23.-25. July, 2014. Manchester: Manchester Metropolitan University, 2014, 1.-6.lpp.

9. Udaļcovs, A., Bobrovs, V., Ivanovs, Ģ. Power Efficiency vs. Spectral Efficiency and Transmission Distance in 2.5-10-40 Gbps Backbone Optical Networks. No: *6th International Symposium on Communications, Control and Signal Processing (ISCCSP 2014): Proceedings*, Greece, Athens, 21.-23. May, 2014. Piscataway: IEEE Computer Society, 2014, 202.-205.lpp. ISBN 978-147992890-3. Available from: doi:10.1109/ISCCSP.2014.6877850
10. Spolītis, S., Wagner, C., Olmos, J., Bobrovs, V., Ivanovs, Ģ., Monroy, I. Experimental Demonstration of a Scalable Sliceable Transceiver for Optical Access Networks. No: *Asia Communications and Photonics Conference 2014: Conference Proceedings*, China, Shanghai, 11.-14. November, 2014. Shanghai: Optical Society of America, 2014, 1.-3.lpp.
11. Olonkins, S., Spolītis, S., Ļašuks, I., Bobrovs, V. Cost Effective WDM-AON with Multicarrier Source Based on Dual-Pump FOPA. No: *6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT)*, Russia, St. Petersburg, 6.-8. October, 2014. St. Petersburg: 2014, 23.-28.lpp.
12. Ivanovs, Ģ., Bobrovs, V., Olonkins, S., Alsevska, A., Gegere, L., Parts, R., Gavars, P., Lauks, G. Application of the Erbium-Doped Fiber Amplifier in Wavelength Division Multiplexing (WDM) Transmission Systems. *International Journal of Physical Sciences*, 2014, Vol. 9, No. 5, 91.-101.lpp. ISSN 1992-1950. Available from: doi:10.5897/IJPS2013.4066
13. Bobrovs, V., Poriņš, J., Spolītis, S., Ivanovs, Ģ. Design and Implementation of WDM-PON Solutions. No: *Advances in Optical Communication. Chapter 1*. D.Narottam red. Rijeka: Intech, 2014. 3.-34.lpp. ISBN 978-953-51-1730-8. Available from: doi:10.5772/59052
14. Olonkins, S., Bobrovs, V., Ivanovs, Ģ. Investigation of Fiber Optical Parametric Amplifier Performance in DWDM Transmission Systems. *Electronics and Electrical Engeneering*, 2014, Vol.20, Iss.1, 88.-91.lpp. ISSN 1392-1215. e-ISSN 2029-5731. Available from: doi:10.5755/j01.eee.20.1.6170
15. Bobrovs, V., Spolītis, S., Ivanovs, Ģ. Latency Causes and Reduction in Optical Metro Networks. *Proceedings of SPIE*, 2014, Vol.9008: Optical Metro Networks and Short-Haul Systems VI, 1.-11.lpp. ISSN 0277-786X. Available from: doi:10.1117/12.2041736
16. Udaļcovs, A., Monti, P., Bobrovs, V., Schatz, R., Wosinska, L. Powerefficiency of WDM Networks Using Various Modulationformats with Spectralefficiency Limited by Linear Crosstalk. *Optics Communications*, 2014, Vol.318, 31.-36.lpp. ISSN 0030-4018. Available from: doi:10.1016/j.optcom.2013.12.033

Table 5: Teaching staff of the doctoral study programme “Telecommunications”

Name, surname	Position	Scientific degree	LZP experts	LZP expert rights expiration date	h-index
Vjačeslavs Bobrovs	Professor	Dr.sc.ing.	Engineering Sciences and Technologies-Nano Technology	05.01.2025.	13
			Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	03.02.2024.	
			Natural Sciences-Physics and Astronomy	06.04.2025.	
			Natural Sciences-Computer Sciences and Information Science	06.05.2025.	

Ģirts Ivanovs	Professor	Dr.sc.ing.	Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	04.05.2025.	11
Jurģis Poriņš	Professor	Dr.sc.ing.	Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	01.09.2024.	8
			Natural Sciences-Physics and Astronomy	06.10.2024.	
Sandis Spolītis	Professor	Dr.sc.ing.	Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	01.09.2024.	10
			Natural Sciences-Physics and Astronomy	03.03.2024.	
Andris Ozols	Professor	Dr.habil.	Engineering Sciences and Technologies-Material Science	02.06.2024.	13
Andis Supe	Asoc. professor	Dr.sc.ing.	Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	04.05.2025.	3
Oskars Ozoliņš	Asoc. professor	Dr.sc.ing.	Natural Sciences-Physics and Astronomy	01.06.2025.	19
			Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	06.07.2025.	
			Natural Sciences-Computer Sciences and Information Science	01.06.2025.	
Xiaodan Pang	Asoc. professor	Dr.sc.ing.	Natural Sciences-Physics and Astronomy	01.12.2024.	22
			Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies	01.12.2024.	
			Natural Sciences-Computer Sciences and Information Science	01.12.2024.	
Alexander Shalin	Guest assoc. professor	Dr.habil.	-	-	31

Guntis Ancāns	Docent	Dr.sc.ing.	-	-	4
Elans Grabs	Docent	Dr.sc.ing.	-	-	3
Aleksandrs Mariņins	Docent	Dr.sc.ing.	-	-	6
Inna Kurbatska	Senior researcher	Dr.sc.ing.	-	-	3

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

All teaching staff members of the study programme take part in or conduct various types of international, local, scientific and research projects, ERDF, FLPP and others. The teaching staff also participate in international ERASMUS+ projects, elaborating new study courses. Scientists regularly report on project results in conference and journal publications and use such results in their pedagogical work - in lectures, seminars, and other classes with students, as well as in learning materials and monographs. Many graduation papers are written within the framework of projects and about the project's scientific activity and results.

The teaching staff of the study programme implement national and international research projects:

- **ERDF project “Ring-Resonator Modulators for Optical Interconnects (RINGO).”**

Project implementation period: 01.01.2022. - 30.11.2023.

Project implementer: Oskars Ozoliņš, Aleksandrs Mariņins, Ģirts Ivanovs

Project cooperation partner: AFFOC Solutions SIA

Project financing: 540540.00 EUR incl. ERDF financing 443026.58 EUR, national public financing 68239.18 EUR, and national private financing 29274.24 EUR.

Project description: It is anticipated to develop an energy-efficient optical transmitter for optical interconnects based on the ring-resonator modulators using silicon on insulator technology. In the RINGO project, the main attention will be drawn to the ring-resonator modulator (RRM) applications with improved, spectrally efficient modulation formats in order to increase the capacity of optical interconnects. Taking into account the periodic nature of the transmitters based on RRM, various channels will be used in order to increase the capacity of optical interconnects.

- **FLPP project “Dynamics of non-scattering states in nanophotonic (DNSSN).”**

Project implementation period: 03.01.2022. – 30.12.2024.

Project implementer: Alexander Shalin

Project scientific manager: Vjačeslavs Bobrovs

Project total financing: 299966.70 EUR

Project description: The project contains scientific activities, which are directed to the development of new technologies and acquisition of new interdisciplinary knowledge, promotion of innovations, as well as to well-designed knowledge and technology transfer strategy, which will definitely create new knowledge for the improvement of the competitiveness of the national economy and for development of the human capital.

- **ERDF project "Photonic-Assisted Signal Processing for Optical Interconnects (CARAT)."**

Project implementation period: 01.01.2021. - 30.06.2023.

Project implementer: Oskars Ozoliņš, Xiaodan Pang

Project scientific manager: Vjačeslavs Bobrovs

Project financing: 111504.90 EUR incl. ERDF financing 94779.16 EUR (85%), state budget financing 11150.49 (10%) and Riga Technical University financing 5575.25 EUR (5%).

Project description: CARAT project will be implemented by the Institute of Telecommunications (IT) of Riga Technical University (RTU) and is devoted to the development of optical interconnector technology of data centres according to the improvement of the corresponding optical transmission systems, which is particularly actual taking into account sky-rocketing development of data centres. CARAT project is industrial research not connected with economic activity. The project aims to develop information and communication technology solutions to create sustainable and energy-efficient optical interconnectors. The objective corresponds to the specialisation field "Information and Communication Technology" (ICT) of the Smart Specialisation Strategy (RIS3) and the 4th growth priority - The development of modern and up-to-date ICT systems in the private and public sectors. Project main actions and activities are the following: (1) mutual knowledge transfer between RTU and a post-doctoral student; (2) modelling of the influence of component disadvantages on optical interconnectors; (3) elaboration and introduction of systematic assessment methods for photonic signal processing; (4) system-level experiments with high-speed multi-level signals; (5) Improved photonic signal processing method for multi-level signals. As a result, research outcomes are obtained, which will be topical for optical interconnectors of data centres, and also photonic signal processing method will be provided. Thus, the activities anticipated in the project will provide a significant contribution to the development of ICT systems according to RIS3 objectives. The anticipated results include 3 scientific publications as well as conference theses or abstracts.

- **ERDF project "Development of optical frequency combs for fiber-optic communication systems (COMBSYS)."**

Project implementation period: 01.01.2021.-30.06.2023.

Project implementer: Ilya Lyashuk

Project scientific manager: Vjačeslavs Bobrovs

Project financing: 111504.90 EUR incl. ERDF financing 94779.16 EUR (85%), state budget financing 11150.49 (10%) and Riga Technical University financing 5575.25 EUR (5%).

Project description: An industrial research not connected with economic activity, which corresponds to the Latvian Smart Specialisation Strategy (RIS3) for the 4th growth priority, where the development of modern ICT systems is anticipated. The objective of the project is to research and develop various types of optical frequency comb (OFC) generators for fiber optical communication systems to increase data transmission performance, which is particularly important when the society performs remote work from home or studies from home as it was observed in the circumstances of the global COVID-19 epidemiological crisis. The planned activities include research of OFC generators based on various physical implementations and constructions. As a result, these technologies will be evaluated by performance thereof, for example, by the generated carrier line width, quality factor Q, and received data signal bit error coefficient (BER), which will allow finding the most appropriate OFC technology for modern wavelength division multiplexing (WDM) for fiber optical communication systems. The project also includes mobilities to foreign countries, long-term research activities, obtaining new knowledge, and creating of innovations, followed by knowledge dissemination. The project is anticipated to prepare and submit at least 4 original scientific publications and develop a new OFC technology. The project will be implemented by the institution-Riga Technical University Institute of Telecommunications, attracting a foreign scientific institution - the Russian Academy of Science Federal Research Institution of Applied Physics (IAP RAS).

- **ERDF project "Modeling of the converged Fiber Optical Access Networks."**

Project implementation period: 01.05.2020. until 30.04.2023.

Project implementer: Inna Kurbatska

Project scientific manager: Vjačeslavs Bobrovs

Project financing: 133805.88 EUR incl. ERDF financing 113734.99 EUR (85%), state budget financing 13380.58 EUR (10%) and Riga Technical University financing 6690.31 EUR (5%).

Project description: The objective of the application for research is to define requirements for the elements of the converged fiber optical access networks and enhance the existing fiber-optical transmission system simulation software opportunities with topical models of new, convergent access networks.

- **ERDF project "Development of efficient clad-pumped fiber optical amplifiers for telecommunication systems."**

Project implementation period: 01.06.2019. -31.05.2022.

Implementers: Andis Supe, Sandis Spolītis

Project scientific manager: Jurģis Poriņš

Project cooperation partners: AFFOC Solutions SIA, University of Latvia Institute of Solid State Physics

Project financing: Total eligible costs are 648000 EUR, including ERDF financing in the amount of 374544 EUR.

Project description: This project, together with the company in the field, anticipates the development of a new fiber optical amplifier for optical transmission systems. The most attention in this project is directed to the study of doped optical fiber amplifiers. In more detail, the application of various combinations of impurities and double-shell profile fiber is pumped with rentable multi-mode light sources for use in wavelength division multiplexing (WDM) transmission systems to increase the length of the optical transparent transmission path.

- **ERDF project "Development of optical frequency comb generator based on a whispering-gallery-mode microresonator and its applications in telecommunications."**

Project implementation period: 16.05.2019 - 15.05.2022.

Project implementers: Andis Supe, Sandis Spolītis, Jurģis Poriņš

Project scientific manager: Vjačeslavs Bobrovs

Project cooperation partners: AFFOC Solutions SIA, University of Latvia

Project financing: Project total costs are EUR 648000, where ERDF contribution is EUR 374544 (57,8% of the total budget), state budget part is EUR 224856 (34,7%). The budget is distributed among 3 partners: University of Latvia (40%), Riga Technical University (20%), and SIA "AFFOC Solutions" (40%).

Project description: The objective of the project is to obtain new knowledge about whispering-gallery-mode resonators for optical frequency combs (ČGM - in Latvian, WCOMB - in English) and to develop, construct and test the comb generator prototype for applications of telecommunications. The project promotes the growth priorities defined in the Latvian Smart Specialisation Strategy: (3) Smart materials, technologies and engineering systems (new WCOMB resonators and frequency comb technologies will be developed); (5) Information and Communication Technologies (applications of WCOMB resonator frequency combs in telecommunications will be developed).

- **ERDF project "Generation of Concatenated Forward Error Correction Codes for High-Speed Optical Communication Networks (FECON)."**

Project implementation period: 01.03.2020 until 28.02.2023.

Project implementer: Svitlana Matsenko, Rolands Parts (assistant)

Project scientific manager: Vjačeslavs Bobrovs

Project financing: 133805.88 EUR incl. ERDF financing 113734.99 EUR (85%), state budget financing 13380.58 EUR (10%) and Riga Technical University financing 6690.31 EUR (5%).

Project description: The objective of the research project is to study and develop valid non-concatenated/concatenated FEC codes for fiber optical communication networks (OCN), where advanced optical signal modulation formats are also used to provide spectral effective data transmission.

- **ERDF project "New type embedded robust chaotic oscillators for secure communication systems."**

Project implementation period: 01.06.2021.-31.05.2023.

Project implementer: Aleksandrs Ipatovs

Project scientific manager: Dmitrijs Pikuļins

Project financing: 89203.92 EUR incl. ERDF financing 75823.33 EUR (85%), state budget financing 8920.39 EUR (10%) and Riga Technical University financing 4460.20 EUR (5%).

Project description: The research objective of the project is to elaborate methodology for a new type of robust switched chaotic generator applications for secure communication systems. The obtained project results would promote the development of resource-efficient and secure communication systems, which would contribute to the national economy, including the development of smart cities, smart agriculture, and e-health, which is particularly important in cases of emergencies (natural disasters, Covid-19 pandemic, etc.), when the mobility of inhabitants is limited, and demand for secure remote data exchange significantly increases.

- **ERAF co-financed project "RTU innovation grants for students": Development and Evaluation of Multi-functional Fiber Optical Sensor System**

Project period: 01.01.2019. -17.06.2022.

Project implementer: doctoral student Jānis Braunfelds

Project cooperation partner: Latvijas Mobilais Telefons SIA

Financing: LMT 50000 Euro and RTU 50000 Euro

Project objective: The industrial doctoral project with LMT and ERDF “Industrial doctor” is an elaboration of a Doctoral thesis research observing the interests and needs of the enterprise. In preparation of doctoral students acquisition of scientific methods is usually based on the problem statements created in the academic environment; as a result, there is not any clear connection with the industry and needs thereof. The aim of this activity is to provide financial support for young scientists who elaborate Doctoral thesis on the topics valuable for the development of the enterprise and whose scientific results are necessary for the development of the corresponding enterprise. In cooperation with the enterprise, the university prepares a doctor of science in the topics initiated by the enterprise. The doctoral student works in the university but is actively involved in R&D activities of the enterprise. The chosen topic is based on university scientific excellence and the strategical outlook of the enterprise in technology development.

- **RTU scientific research project “Application of sensor technologies for determination of clothes size fitness.”**

Project period: 01.01.2021. - 31.12.2021.

Senior project manager: Researcher Toms Salgals

Cooperation partner enterprise: SIA "AFFOC Solutions."

- **RTU scientific research project “Fiber optical FBG sensors for monitoring the technical condition of roads.”**

Project period: 02.01.2020. - 31.12.2020.

Senior project manager: Researcher Jānis Braunfelds

Cooperation partner: SJSC “Latvijas Valsts Ceļi” Road competence centre

- **ERDF project “Computer networks traffic management using machine learning techniques.”**

Project implementation period: 01.12.2018. until 30.11.2021.

Project implementer: Elans Grabs

Project scientific manager: Prof. Ernests Pētersons

Project financing: 133805.88 EUR incl. ERDF financing 113734.99 EUR (85%), state budget financing 13380.58 EUR (10%) and Riga Technical University financing 6690.31 EUR (5%).

Project description: the main objective of the research project is to develop new machine learning techniques for computer network traffic processing both in wired and wireless networks with the aim to improve the total performance of the network.

- **ERDF project “Passive Fiber Optical Sensors for Energy Efficient Monitoring of the Technical Condition of a Transport Infrastructure.”**

Project implementation period: 01.03.2017. -01.03.2020.

Project implementers: Andis Supe, Sandis Spolītis, Jurģis Poriņš

Project scientific manager: Vjačeslavs Bobrovs

Project cooperation partners: AFFOC Solutions SIA

Project financing: 648000.00 EUR, incl. ERDF contribution 550800.00 EUR

Project description: The project is anticipated to elaborate on new energy-efficient, and Optical Fiber Bragg Grating (FBG) based optical sensors and solutions of the optical signal processing system for continuous monitoring of the technical condition of roads and banks. The most attention in this practice-oriented project is drawn to the research of innovative FBG sensor technology and solutions used to observe material wear - mechanical parameter changes, micro cracks in road constructions, and deformations of banks.

- **ERDF project "Next-Generation High-Speed Fiber Optical Access Systems (NG-FAST)."**

Project implementation period: 01.01.2018. until 31.12.2020.

Project implementers: Sandis Spolītis, Inna Kurbatska (assistant)

Project scientific manager: Prof. Vjačeslavs Bobrovs

Project financing: 133805.88 EUR incl. ERDF financing 113734.99 EUR (85 %), state budget financing 13380.58 EUR (10 %) and Riga Technical University financing 6690.31 EUR (5 %).

Project description: The project addresses the challenges of developing high-speed fiber optical access systems which are more spectral-efficient and potentially will provide higher data transmission speeds. The objective of the application for research is to study and develop high-performance data transmission technologies, including complex solutions for direct reception fiber optical access networks with multi-level pulse amplitude modulation (M-PAM) format.

- **ERDF project "All-optical Signal Regeneration Using Nonlinear Optical Effects."**

Project implementation period: 01.01.2018. until 31.12.2020.

Project implementer: Andis Supe, Kaspars Zaķis (assistant)

Project scientific manager: Prof. Jurģis Poriņš

Project financing: 133805.88 EUR incl. ERDF financing 113734.99 EUR (85 %), state budget financing 13380.58 EUR (10 %) and Riga Technical University financing 6690.31 EUR (5 %).

Project description: The project research field is connected with signal interferences created during optical transmission, the study of ways of regeneration thereof and the elaboration of a new optical regeneration technology, which will provide improvement in transmission quality. The objective of the research project is to study and develop the all-optical signal regeneration technology, which includes applicability in single-channel and multi-channel fiber optical transmission systems. The activities planned within the project include research of optical interference sources and the currently used and studied amplitude and phase-modulated signal regenerators in order to improve regenerator activity as the result of analytical and experimental research, taking into account the influence of the parameters of regenerated signals, optical fiber and transmission system. The anticipated result is a new all-optical signal regeneration technology applicable in single-channel and multi-channel transmission systems. The project also includes mobilities to a foreign scientific institution.

- **The national research programme "Cyber-physical systems, ontologies and biophotonics for safe&smart city and society" (VPP SOPHIS)**

Project implementation period: 01.06.2014. – 01.06.2017.

Project implementers: Andis Supe, Sandis Spolītis, Vjačeslavs Bobrovs, Ģirts Ivanovs

Project manager: Modris Greitāns, Jurģis Poriņš (from Institute of Telecommunications)

Project cooperation partners: Institute of Electronics and Computer Sciences (EDI), University of Latvia Faculty of Computer Science (LU DF), University of Latvia Institute of Atomic Physics and Spectroscopy (LU ASI), Agency of the University of Latvia "The Institute of Mathematics and Computer Science, University of Latvia" (LU MII), Riga Technical University Faculty of Computer Science and Information Technology (RTU DITF), Riga Technical University Institute of Telecommunications (RTU IT), Riga Technical University Faculty of Civil Engineering Water Research Laboratory (RTU UPL).

The total planned financing of the programme: 2250000.00 EUR

Project description: The goal of SOPHIS is the development of the next generation ICT systems focused on solutions of tasks crucial for Latvian society and contributing to the economic transformation of products and services with high added value, which is connected with the decrease of digital crack, health, transport, social security.

- **ESF project "Smart City technologies to improve the quality of life."**

Project implementation period: 01.09.2013. – 31.08.2015.

Project implementers: Andis Supe, Sandis Spolītis, Vjačeslavs Bobrovs, Jurģis Poriņš

Project scientific manager: Kaspars Sudars

Project financing: 349999 LVL, from this ESF financing 315454 LVL

Project description: The general objective of the project is to promote the attraction of additional human resources to science in the Institute of Electronics and Computer Sciences and the Institute of Telecommunications of Riga Technical University, attract young scientists and foreign scientists, and create an interdisciplinary scientific group, which performs research in the field of smart city development, paying particular attention to data transmission and acquisition. The specific objective of the project is to perform, within the framework of smart city research, research in the fields of modern data acquisition, data transmission and information processing in order to improve quality of life, paying particular attention to the elaboration of a new data transmission technology.

- **ERDF project "Development of the next-generation electronic communication networks in rural regions."**

Project implementation period: 01.04.2012. – 31.08.2015.

Project implementers: Andis Supe, Sandis Spolītis, Vjačeslavs Bobrovs, Jurģis Poriņš

Project cooperation partner: LVRTC.

For the first stage of the project, the financing of 26 million euros was allocated, where 87,18% was ERDF co-financing, but the other part was financed from LVRTC funds.

Project description: The project objective is to develop the next-generation networks (NGN) in remote rural areas of Latvia and to promote the acquisition of objectives of the strategy «Eiropa 2020» (until the year 2020 to provide all households with an opportunity to receive Internet access with the minimal speed of 30 Mbit/s and for 50 % of households in the year 2020 to give the Internet access speed of at least 100 Mbit/s). The project anticipates expanding 7000 km of optical line, which would provide optical network access to 500 access points.

- **ESF project "Creation of an ICT scientific group for transmission, processing and management of large volumes of data."**

Project implementation period: 01.09.2013. – 31.08.2015.

Project implementers: Ģirts Ivanovs, Oskars Ozoliņš, Andis Supe, Sandis Spolītis, Jurģis Poriņš

Project scientific manager: Vjačeslavs Bobrovs

Project cooperation partner: Agency of the University of Latvia "The Institute of Mathematics and Computer Science, University of Latvia."

Project total financing: 349999.00 LVL, incl. ESF financing 323644.00 LVL (90.13%), State budget financing 25305.00 LVL (9.67%), Riga Technical University and Agency of the University of Latvia "The Institute of Mathematics and Computer Science, University of Latvia" financing 594.00 LVL (0.20%).

Project description: The objective of the project is to promote the attraction of additional human resources to Riga Technical University by creating an interdisciplinary scientist group for transmission, management and processing of large volumes of data (in the field of ICT), attracting young scientists and foreign scientists.

- **RTU scientific research project "Study of multifunctional fiber optical sensor network solutions."**

Project implementation period: 01.12.2016. – 30.11.2017.

Project implementers: Andis Supe, Sandis Spolītis, Jānis Braunfelds

Project scientific manager: Vjačeslavs Bobrovs

Project description: The objective of the project is to elaborate a realistic mathematical simulation model of a fiber optical FBG sensor network and to evaluate its activity in the fiber optical network infrastructure using mathematical modelling tools.

- **ERDF project "Development of high-speed optical access networks and elements thereof."**

Project implementation period: 01.12.2010. – 30.11.2013.

Project implementers: Ģirts Ivanovs, Jurģis Poriņš

Project scientific manager: Vjačeslavs Bobrovs

Project cooperation partners: University of Latvia Institute of Solid State Physics, TEKA Telekom

Project financing: 427284.00 EUR, incl. The volume of ES fund financing: 389332.00 EUR, volume of national public financing: 31567.00 EUR.

Project description: The objective of the project is the creation of a series of new optical elements and a traffic management algorithm, as well as an elaboration of optical network technology with significantly improved access.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the

moment of the submission of the Self-Assessment Report).

In the study programme, there is a mutual cooperation mechanism among the teaching staff, which promotes improvement of the study courses and interrelation thereof. There is a regular improvement of study courses, taking into account the recommendations from students, field development tendencies and the newest research and scientific work results. Mutual cooperation takes place within a semester, when conducting study courses and also when planning changes in the study programme and preparing development plans for the semester and the programme.

During the implementation of study courses and the scientific work, there are regular meetings of the teaching staff, where experience exchange takes place in relation to results of scientific work, updates in the research and the topic of the study courses. During the meetings, the content of studies is developed and improved by mutual agreement on topics, responsibilities and compliance to normative requirements. All members of the teaching staff of the study courses are involved in the process of reconciliation of the study courses.

The study programme is elaborated in order to provide a consequent development of knowledge, skills and competencies, which is based on individual and group work and continuous communication of a doctoral student and his/her advisor.

The first stud year offers general education courses, which are acquired by all doctoral students involved in doctoral studies. At the end of the first study year, at least one original scientific publication is prepared and submitted for publishing, and one verbal or stand thesis is presented at an international scientific conference. The scientific work is performed under the supervision of the scientific advisor.

The second study year is devoted to specialised study courses and doctoral study seminars, as well as to elaboration of the Doctoral thesis. The scientific work is performed under the supervision of the scientific advisor.

The third study year is devoted to scientific work, research, publication of research results and mobility within projects. A doctoral student works individually, cooperation with a paper advisor is provided, as well as there are regular meetings with other doctoral students to give experience and knowledge to exchange information. Continuation of work in the field of scientific publications. The scientific work is performed under the supervision of the scientific advisor.

In the fourth academic year, the final stage of studies is implemented, preparation of the Doctoral thesis for submission to the Promotion Council of RTU “P-08”. Continuation of work in the field of scientific publication development. The fourth study year is finished with a defence of the doctor’s Doctoral thesis.

Doctoral students are offered opportunities of mobilities to other higher educational institutions or traineeships in industrial enterprises.

For improvement of the content of the study programme, for mutual cooperation of the teaching staff and for experience exchange, such events are used: teaching staff seminars, science commission meetings, Promotion Council meetings, doctoral student seminars, academic conferences and other promoting events.

The number of students in the last 4 academic years has been accordingly (2018/2019) – 32, (2019 /2020) - 35, (2020/2021) - 42 and (2021/2022) - 46; therefore, there are in average 3 students per one teacher in the study programme “Telecommunications”.

Considering the fact that academic staff from other RTU structural units works in the study programme, as well as guest lecturers and foreign lecturers, the ratio of students and teachers can be evaluated and analysed in the context of the ICT study field and the FET Faculty.

Currently, the student and teaching staff ratio is 3, which corresponds to the average level of leading world universities.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_EDC0(51523)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_EDC0(51523)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	Nr_39_RTU_doktora_250_stud_Telekomunik.zip	Nr_39_RTU_doktora_250_stud_Telekomunik.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_EDC0(51523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_EDC0(51523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard		
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_EDC0(51523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_EDC0(51523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EDC0(51523)_Plans_lv_Plan_eng.pdf	P09_3.2.1_EDC0(51523)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_EDC0(51523)_StudyCoursesdescr_ENG.zip	P10_EDC0(51523)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)	EDC0(51523)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip	EDC0(51523)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Business Informatics (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Business Informatics*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Mārīte*
Surname of the study programme director	*Kirikova*
E-mail of the study programme director	*marite.kirikova@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*26188383*
Goal of the study programme	*The aim of the Business Informatics study programme is to prepare professionals with expertise in systems thinking and engineering sciences who are able to use, choose, develop, and acquire ICT solutions that enable enterprise development; who are able to design intra- and inter-organizational information systems and are capable of participating in corresponding interdisciplinary and international projects.*
Tasks of the study programme	** To develop students' systems thinking ability and their skills to use systems theory in constructing solutions which promote the development of businesses and science. * To integrate business in ICT topics at different levels of granularity (inside the courses and among the courses). * To apply the newest ICT developments in the study process, facilitate self-organized studies and technology-supported as well as traditional teamwork/group work. * To assure the learning outcomes defined for the programme. * To prepare students for their doctoral studies. * To assure the flexibility of the study programme and possibility to modify it in order to follow changes in the labor market and new developments in different ICT and business areas. * To develop cooperation with similar or topic-related programmes in other countries within ERASMUS and other agreements.*

Results of the study programme	*Graduates of the study programme: * Can identify business goals which are supportable by ICT solutions. * Can identify business problems which are solvable by ICT solutions. * Can, using appropriate technologies, model and analyse business processes, enterprise and business architecture, and information flows, as well as to design internal and inter-institutional information systems. * Are able to follow advances concerning computer systems, communication technologies, and software and methods of their usage and to suggest various solutions and their combinations for raising competitiveness of enterprises and enterprise networks. * Are able, using appropriate technologies, to develop enterprise improvement strategies, to plan analysis and change management projects, and define requirements for new products and services. * Are able to interpret business concepts in computer science and ICT terms and vice versa. * Can motivate, educate, and train employees to use the most appropriate ICT solutions, as well as participate in and lead inter-disciplinary and international teams. * Are able to participate in international scientific projects in the area of business informatics as well as to propose and lead scientific projects. * Are able to follow the rules of ethics in business and information systems development, and systems analysis.*
Final examination upon the completion of the study programme	*Final examination procedure includes development of Master Thesis (20 CP). The Master Thesis is author's original research, where methods, models, techniques and prototypes applicable for solving tasks in the field of business informatics are analytically or experimentally assessed and/or integrated and/or designed. The purpose of the Master Theses is to give students an opportunity to apply their knowledge and skills in the field of scientific research in order to gain a firm foundation for post graduate studies; to further develop their competence in decision making, problem identification, analysis, and solving, as well as to promote creativity and sharpen professional discussion and presentation skills proving their ability to accomplish scientific research and discuss it at a high professional level. The learning outcomes of Master Thesis (as the outcomes of all study courses) are evaluated according to 10 grade (10 – the highest) system according to Regulation on the Assessment of Learning Outcomes of RTU (29 May 2017, Minutes No 610).*

Study programme forms

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*

Admission requirements (in English)	*Bachelor Degree in Engineering Science, or Natural Sciences or Social Sciences (Economics, Management), or Professional Bachelor Degree in the fields of practical activity corresponding to the named fields of science, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Business Informatics*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Part time studies - 2 years, 6 months - english

Study type and form	*Part time studies*
Duration in full years	*2*
Duration in month	*6*
Language	*english*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree in Engineering Science, or Natural Sciences or Social Sciences (Economics, Management), or Professional Bachelor Degree in the fields of practical activity corresponding to the named fields of science, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Business Informatics*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The academic Master study programme “Business Informatics” has been developed and implemented in accordance with the requirements of the European Common Educational Area, the regulatory enactments of the Republic of Latvia and the decisions of RTU Senate. As a result of academic studies, students acquire theoretical knowledge, skills and competences in accordance with the 7th level of the Latvian Classifications Framework. The programme has the following main components: Part A - Compulsory courses, Part B - Compulsory elective courses (where B1 Field-specific study courses and B2 Humanities and social sciences study courses), Part C - Free elective courses, and Master Thesis.

During the accreditation period, the following changes have been made to the programme parameters:

1. The education classification code has been changed to 45526 (Other engineering sciences), following the changes in the state education classification code system. During the previous accreditation period, the code of the study programme was 45481, which was in the group of computer science education programmes along with Natural Sciences, Mathematics and Information Technology thematic groups. The need to change the code arose due to Cabinet Regulations No. 322. Code 45526 has been chosen considering that the study programme “Business Informatics” educates and trains specialists capable of thinking and operating in engineering and uses research results appropriate to the field of computer science and information and communication technology (ICT). A study of various sources, including university programmes in the European Union and elsewhere, shows that ICT is today an engineering field that aims to develop research methods, tools, approaches, technologies and technical solutions to practical problems to improve people's living conditions. This distinguishes information and communication technologies as an engineering discipline that uses scientific knowledge to solve practical and technical problems to create things that do not exist in nature, from natural science, which studies the regularities and phenomena that exist in nature.
2. The preconditions for admission have been changed to a Bachelor degree in engineering or natural sciences or social sciences (economics, management) or a professional Bachelor degree in the fields of practical activity corresponding to the named fields of science or equivalent education. Only the form of the statements has been changed here, without changing the nature of the preconditions.
3. The following changes have been made in the formulation of preconditions for application to the programme: English language proficiency has been changed to B2 level according to CEFR and university study courses at the Bachelor level (Level 6 of LQF / EQF) within the following topics and in the following volume: databases (2 CP), computer networks (2 CP), higher mathematics (2 CP), accounting (2 CP), civil defence (1 CP) and environmental protection (1 CP). If a student has not mastered the study topics accounting (2 CP) and civil

defence (1 CP) and environmental protection (1 CP) within the lower-level study programme, they may acquire them at the Master study programme, including appropriate courses in Part C, or in addition to the programme. These changes have been made following the national requirements and the decision of RTU Senate on 30 March 2020 “On the Approval of the Uniform Requirements for the Study Programs of Riga Technical University in a New Edition”.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study programme belongs to the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”, as its content complies with the recommendations of the ACM / IEEE “A Report in the Computing Curricula Series” updated in 2020 in the field of computer science and ICT industry.

The title of the study programme precisely describes the field of study, the aim of the study programme and the learning outcomes, because the programme educates and trains specialists who can promote alignment between business needs and appropriate ICT solutions systematically and based on an engineering approach. This is supported by the fact that the graduates of the study programme work as product development specialists, cloud automation engineers, data visualization engineers, information security engineers, DevOps engineers, artificial intelligence and machine learning engineers, business, ICT, and data analysts, as well as ICT project and department managers. The title of the study programme also corresponds to the tasks of the study programme to integrate business in ICT topics at different levels of granularity (inside the study courses and among the study courses) and to develop cooperation with similar or topic-related programmes in other countries within ERASMUS and other agreements.

The code of the study programme is 45526 which belongs to the Engineering Science and Technology Education group of educational programmes of the thematic area of Other Engineering Sciences. Business informatics as a branch of ICT belongs to the field of engineering science and technology[1], it is developed in accordance with the strategic specialization of Riga Technical University in engineering science and technology, and its content is based on the identification and design of ICT solutions rooted in business needs. This code corresponds to the aim and essence of the study programme and, thus, to its task of assuring the learning outcomes defined for the study programme, which require skills and abilities typical of system engineering tasks, including both problem identification and solution design.

The degree to be obtained is a Master Degree of Engineering Science in Business Informatics. It corresponds to the title of the study programme, its tasks, its study content, and learning outcomes, which confirm the engineering approach to ICT solutions rooted in business needs. This degree, like the title of the study programme, corresponds to the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”. The learning outcomes combine the acquisition of in-depth theoretical knowledge and the development of research skills in the field of business informatics with an emphasis on the abilities to apply principles of engineering and science in analysing problem domains and developing solutions.

According to its specifics, students with bachelor education in ICT and other fields are admitted to the study programme, thus gaining additional knowledge synergy between business and ICT. For students who have not previously studied in the field of ICT, preconditions regarding knowledge in databases (2 CP) and computer networks (2 CP) have been established for admission to the study programme and appropriate study courses have been provided. All students have admission requirements for higher mathematics (2 CP) and accounting (2 CP), as well as civil defense (1 CP) and environmental protection (1 CP) with the conditions of their fulfillment. These requirements have been set to provide a sufficient knowledge base for students to complete the study courses and RTU offers study courses appropriate for their fulfillment.

The volume of the study programme is 80 CP and the duration of full time intramural studies is two years (two years and six month for part time intramural studies), which complies with Cabinet Regulations No. 240 of 13 May 2014 “Regulations on the State Academic Education Standard”. Such duration and volume of the programme allows ensuring the development of knowledge, skills, and competencies necessary for business informatics and the elaboration of scientifically high-quality Master Theses. Part-time studies are offered so that those who want to study, but cannot attend classes five times a week due to work and/or family circumstances, can acquire the study programme’s content over a longer period of time. For achieving the aim of the programme “to prepare professionals with expertise in systems thinking and engineering sciences who are able to use, choose, develop, and acquire ICT solutions that enable enterprise development; who are able to design intra- and inter-organizational information systems and are capable of participating in corresponding interdisciplinary and international projects”, the volume of 80 CP is chosen because it is practically impossible to achieve this aim and the defined learning outcomes with the smaller amount of credit points. In some countries business informatics (or similar business information systems programmes) having smaller volume are combined with 4-year bachelor studies (e.g., in the University of Rostock), however, the RTU study programme is oriented on three-year bachelor studies graduates.

The study program is in English and both local and foreign students study together. Studies in English and the international environment contribute to the fulfillment of the tasks of the study programme and the achievement of study results, for example, ensuring that students:

- Are able to follow advances concerning computer systems, communication technologies, and software and methods of their usage and to suggest various solutions and their combinations for raising competitiveness of enterprises and enterprise networks; because the dominant language in the field of ICT is English and reports about the latest developments in the field are available in English.
- Can motivate, educate, and train employees to use the most appropriate ICT solutions, as well as participate in and lead inter-disciplinary and international teams.
- Are able to participate in international scientific projects in the area of business informatics as well as to propose and lead scientific projects.

Studies in English also make it easier to ensure the flexibility of the study programme, for example, by attracting teachers from other countries, and allow, in the study materials, to respond more quickly to changes in labor market requirements and the development of the ICT field. It also facilitates cooperation with programmes of other universities, which are implemented in English. It also contributes to the communication of the results of students' research work in the international scientific environment.

[1] https://likumi.lv/ta/id/296661-noteikumi-par-latvijas-zinatnes-nozarem-un-apaksnozarem (only in

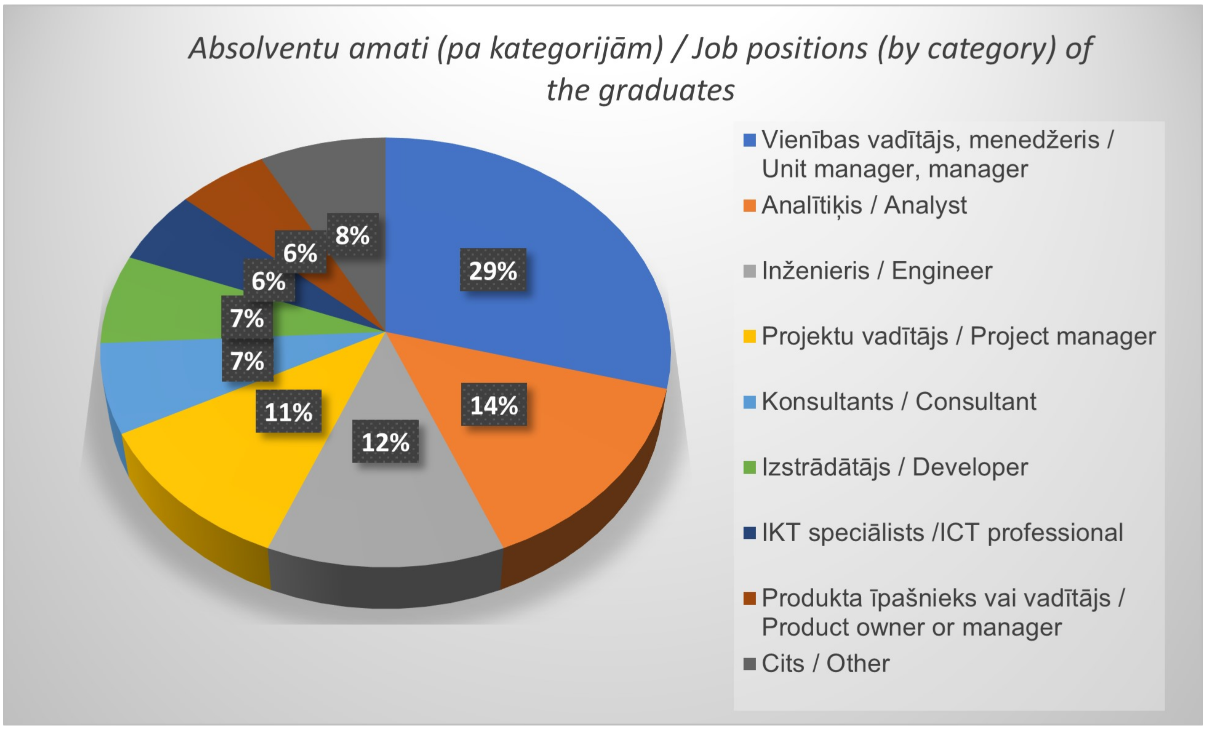
Latvian)

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

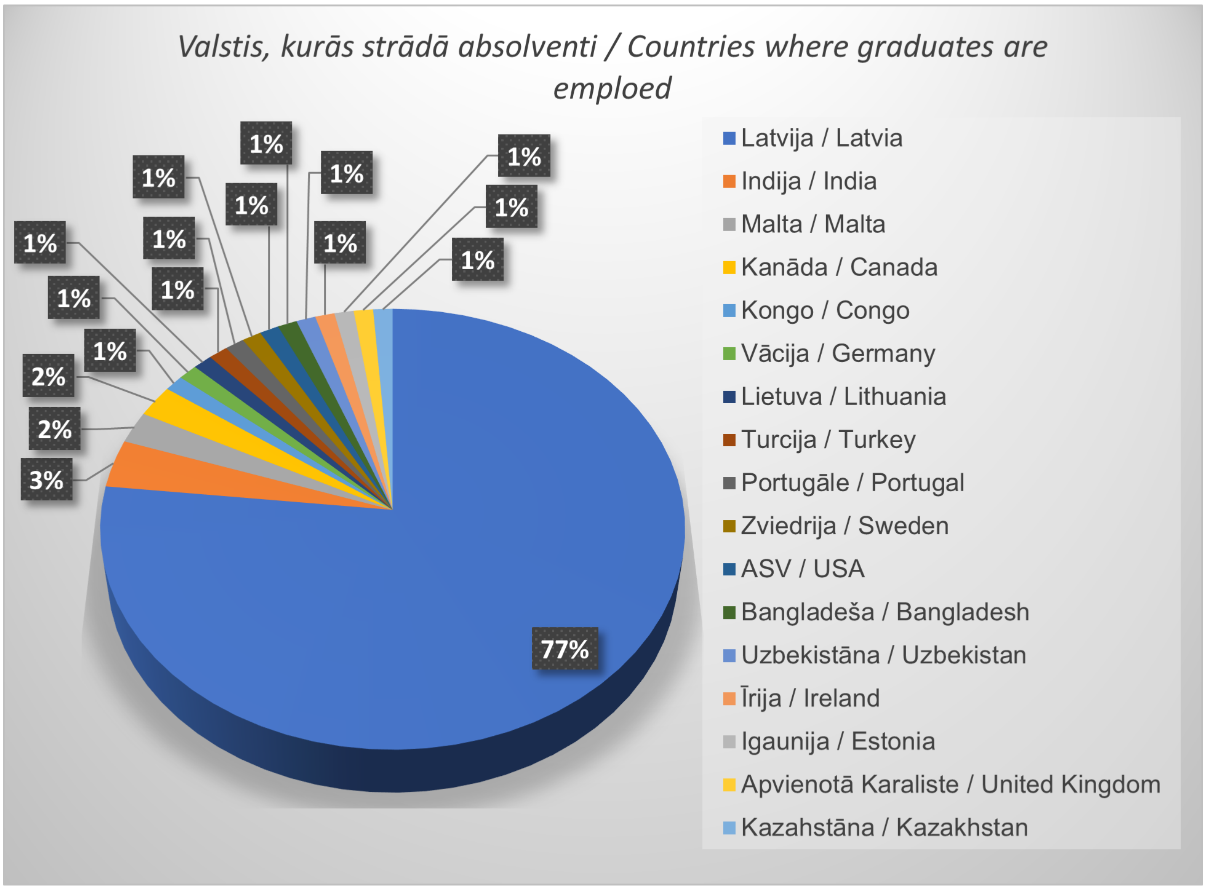
Latvia’s National Development Plan 2021–2027 points out that ICT advances and their widespread availability are a catalyst for change in the economy, public administration, and society. The knowledge of society, through the targeted use of ICT solutions, is transforming existing and creating new processes, business models, habits, and cultures in all areas of the economy and life. The digital transformation is seen as the key to productivity, economic growth, the well-being of the individual and society. At the same time, the number of ICT specialists in Latvia, according to the Digital Economy and Society Index compiled by the European Commission, accounted for only 2.2% of all employees in 2018, which is significantly below the European Union (EU) average or 3.7%. Industry research “Future Goals, Present Directions. Latvia 2022” conducted by Certus think tank in 2017 revealed that Latvian IT industry would need up to 3,000 new graduates per year. The study programme “Business Informatics”, therefore, operates in accordance with the Latvian National Development Plan, contributing to the training of ICT specialists.

According to the Latvian Statistics Portal, the share of companies employing ICT/IT specialists increased by 5% over the last 7 years and reached 73% in 2020. According to the Certus think tank sector study conducted in 2019, “Regional Competitiveness. Latvia's Competitiveness Report 2019” salaries for ICT specialists in the leading EU countries are about 30% above the national average; in Latvia this difference reaches 80%. These data indicate good job prospects for graduates of the study programme “Business Informatics”.

Graduates of the study programme “Business Informatics” work at such important Latvian companies as Accenture, ZZdats, Visma Labs, Luminor Group, C.T.Co, and others; several graduates work for one of the highest-paid companies—Evolution. In total, the graduates of the study programme work for more than 30 Latvian local and international companies; there are companies that employ several graduates of the programme, such as Accenture, which employs seven graduates. The range of positions is fully in line with the profile of the study programme, including application development, analytics, consulting, and ICT project and department management.



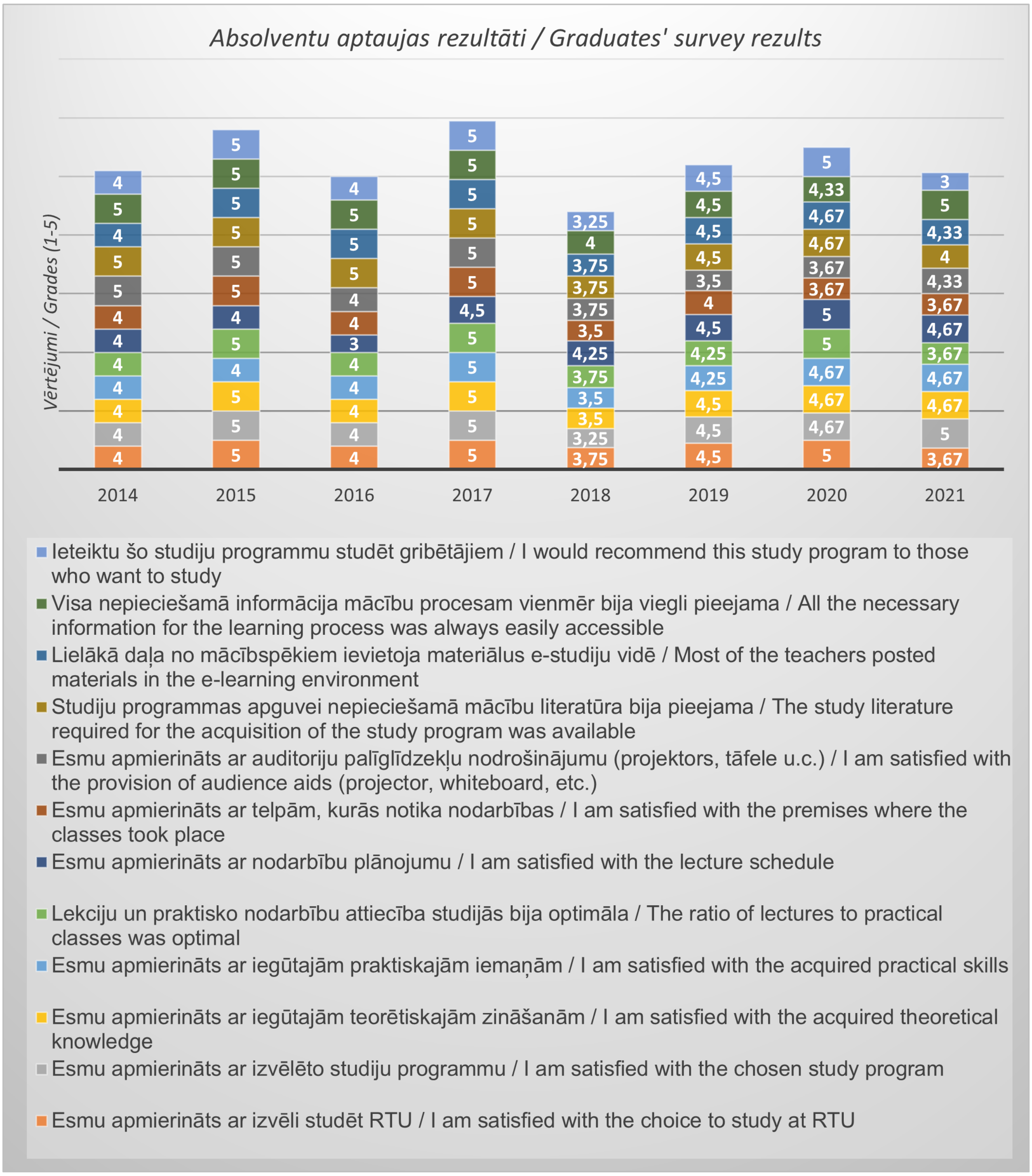
It should be noted that in Latvia, after completing the programme, there are 20 foreign students who stay working in Latvia, which helps to compensate the labour shortage in the ICT sector. Thus, more than half of the foreign residents who have completed the study programme remain to work in Latvia. Almost half of the graduates are residents of Latvia, who mostly stay to work in Latvia. In total, more than 75% of the graduates of the programme work in Latvia. Graduates of the study programme work as data and business analysts, cyber security specialists, information technology support engineers, ICT project managers etc. in the United Kingdom, Ireland, Uzbekistan, India, Malta, Bangladesh, Canada, the United States, Sweden and Portugal. A total of 92 students have completed the study programme, and 77 – in the reporting period.



Almost 20% of graduates are from India. In total, the programme has been completed by residents of more than 16 countries. (Annex P5: Statistics on students of the academic master study programme “Business Informatics”).

Some of the graduates who initially enrolled with a non-ICT undergraduate degree work in the leading positions and use the knowledge gained in the programme to determine the choice of ICT solutions, and many have completely changed their area of professional activities as part of their ICT solution development teams.

Almost all graduates of the programme “Business Informatics” who participated in the surveys expressed a positive opinion about the study programme. In the period of 2014-2021 on a scale of 1 to 5 students highly valued the availability of the necessary information during studies (4.73), the availability of literature (4.62), the provision of classroom aids (4.28) and the work of teachers with the e-learning environment (4.53). Students were also generally satisfied with their choice to study at RTU (4.36) and their choice to study at the programme “Business Informatics” (4.43). Students are satisfied with the acquired theoretical (4.42) and practical (4.26) knowledge, the relationship between lectures and practical classes (4.33), lesson planning (4.24) and the premises (4.1) in which the classes took place. It should be noted that since the survey, the faculty has moved to new premises, where at the time of writing the report, due to the pandemic, students have not yet been able to fully enjoy the learning process. Students also expressed a desire to recommend this study programme to others who are willing to study (4.22).



We can observe a drop in satisfaction in 2018, which is explained by the large number of poorly motivated students from India who had a negative impact on the study process. Measures taken to address this issue are discussed in Section 3.1.4. The impact of this situation can be felt even in 2021, as several foreign students were forced to extend their study time in order to meet all the knowledge quality criteria required for graduation. In general, the study programme has a good atmosphere and the level of graduate satisfaction is high, as well as the graduates have expressed gratitude to the teaching team for the acquired knowledge and skills. Four graduates of the study programme have received diplomas with honours.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and

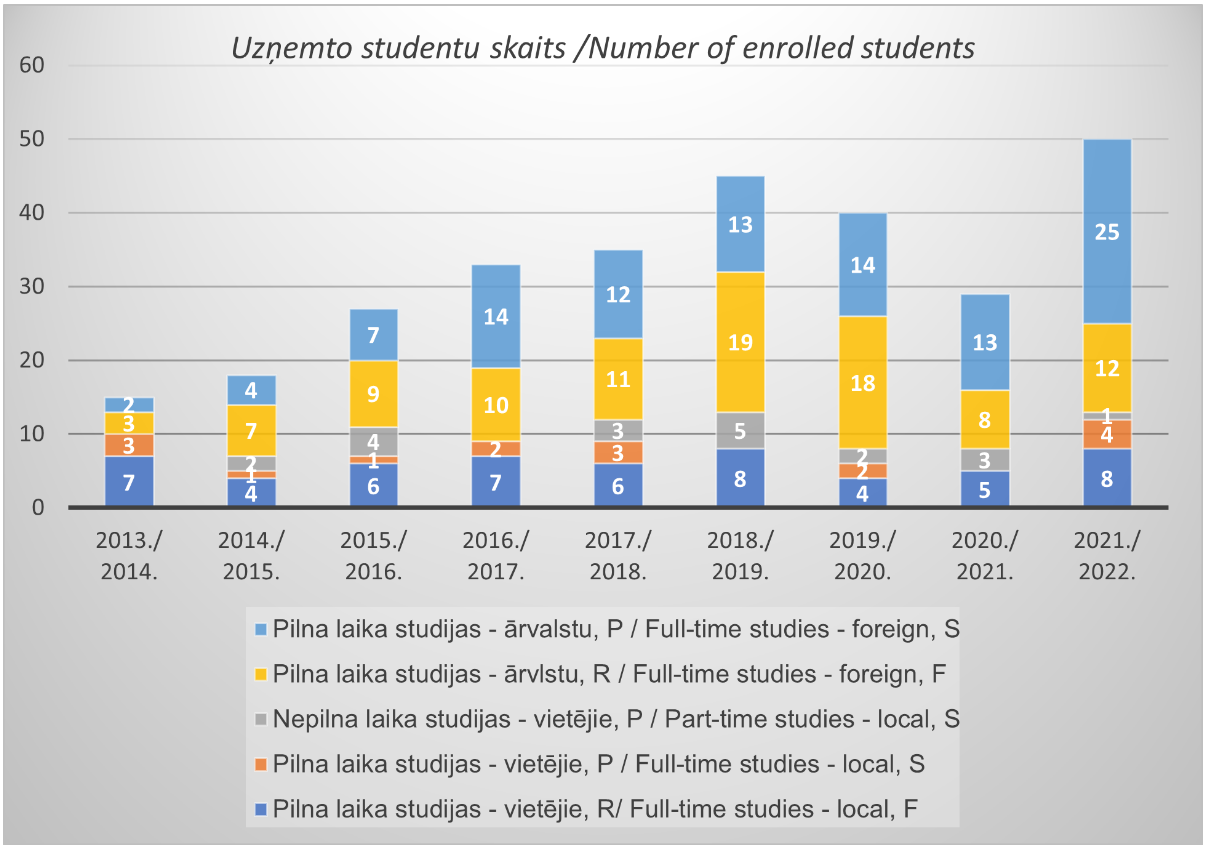
languages.

The academic Master study programme "Business Informatics" is implemented in English in the form of intramural full-time and part-time studies. Part-time studies are offered only to Latvian residents. The study programme has two admissions: summer and winter — for the autumn and spring semesters. The study plans of the study programme are integrated so that only 2 study courses are taught every semester (i.e., twice per year). Thus, both full-time and part-time students from different enrolments take the same study courses at the same time, following their own study course acquisition plans, each of which provides an effective sequence of study courses. This approach ensures both a productive number of students in the classroom and the exchange of knowledge postulated and required between students of the programme. In the reporting period until 2021, students were admitted to part-time studies only once a year. However, to respect the wishes of potential students, since 2021 part-time students may enter during both admission periods. The number of part-time students is relatively small, but the way the study process is organized allows them to integrate well into the overall study process. As already mentioned, in order to ensure a full-fledged study process also for part-time students, two courses are repeated every semester, but this does not decrease the number of students in the classroom, as both courses are popular among exchange students.

The number of students enrolled during the reporting period has gradually increased (albeit with a decline in the first two years of COVID-19). This increase is mainly at the expense of foreign students. A small increase in the number of local students in academic year 2021/2022 can be explained by the compliance of the content of the study programme with the knowledge required for digital transformation. It should be noted that the attraction of foreign students to the programme “Business Informatics” is ensured by the International Cooperation and Foreign Students Department (ICFSD), for which various strategies and techniques have been developed and are constantly being improved. In Latvia, the study programme was initially popularized by the programme administration. However, for several years now this function has been taken over by the responsible organizational units of RTU, which help prepare various informative materials and popularize study programmes.

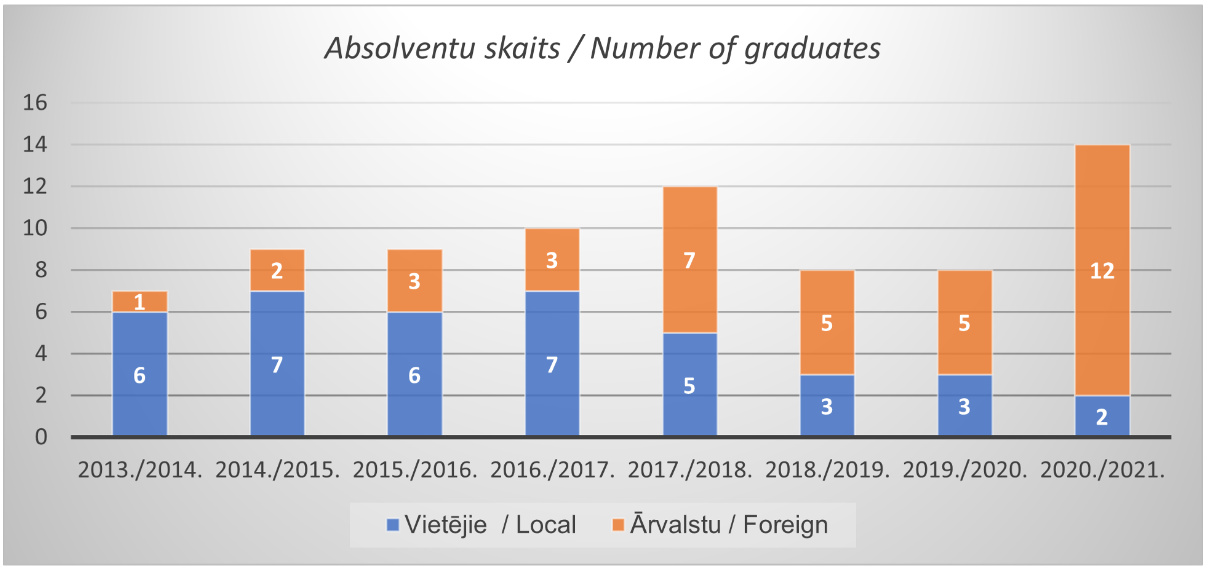
Most of the foreign students come from India, but there is also a large drop-out rate among these students. The period of 2017-2019 was especially severe when the enrolled students were poorly motivated to attend lectures and work independently. Since then, in cooperation with RTU ICFSD, a new procedure has been introduced for the admission of students, where the degree of students' readiness for studies is carefully analysed and additional opportunities for acquiring preliminary knowledge courses are provided. In case of uncertainties, the head of the study programme is also involved in making decisions about the necessary preparation.

The study programme requires a relatively high level of commitment from students, because the study courses cover a wide range of knowledge. The requirements surprise some foreign students, although the study programme has its own website http://bi.rtu.lv, which provides information about the programme and the expected attitude towards studies. Almost all local and also some foreign applicants are interviewed before entering the study programme in order to avoid the wrong choice of the study programme, especially in cases when the applicants have not studied at engineering programmes before. Therefore, there are relatively few cases when students leave the study programme due to its content. More often the main reasons that prevent the realization of the intended plans, especially among local students, include an unexpected increase in the complexity of responsibilities in the personal workplace or the difficulties/changes in personal life.



Several students have taken academic leave. The reasons for extending the term of study are various, both increased workload and changes in career or private life. Over the last two years, the main cause was the increased workload or health problems and stress due to the COVID-19 pandemic.

The dynamics of the number of graduates is similar to the dynamics of enrolment, but smaller. Number of graduates comparing academic years 2013/2014 and 2020/2021 has doubled (from 7 to 14).



Increase in the number of theses publicly presented by foreign students in the last period was probably due to the introduction of a new method for preparing students for the Master Theses, which is implemented within the study course DSP702 “Research Methods in Business Informatics”. Students must participate in the pre-defence of the Master Theses approximately one month before the thesis defence, where students can receive additional advice on completing the work. For the time being, the impact of COVID-19 and the resulting geopolitical instability do not allow us to fully see whether the changes introduced will significantly increase the ratio of graduates to students.

Statistical data on students during the reporting period are provided in Annex P5: Statistics on students of the academic master study programme “Business Informatics”

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Analysing the compliance of the study programme “Business Informatics” with Cabinet Regulations No. 240 “Regulations on the State Academic Education Standard” of 13 May 2014, it can be concluded that the study programme complies with the requirements set out in this standard (comparison with the requirements of the standard is reflected in Annex 6). In its turn, the study courses included in the study programme have been developed in compliance with the effective regulatory enactments: Cabinet Regulation No. 322 on the Classification of Education in Latvia, the Law on Higher Education Institutions (current version), RTU Study Regulations, the Regulations of the Register of Study Courses and RTU Senate Resolution on Assessment of Learning Outcomes of 27 May 2017.

The programme includes study courses that form and develop students' competence for work in the field of business informatics, develop professional, creative, and research skills, as well as create socially responsible specialists capable of working in the field, applying systemic, e.g. scientific and engineering thinking. Specialists who are able to use, find, develop and implement information and solutions promoting business development based on communication technology, designing internal and inter-organizational information systems of organizations, and participating in relevant interdisciplinary and international projects.

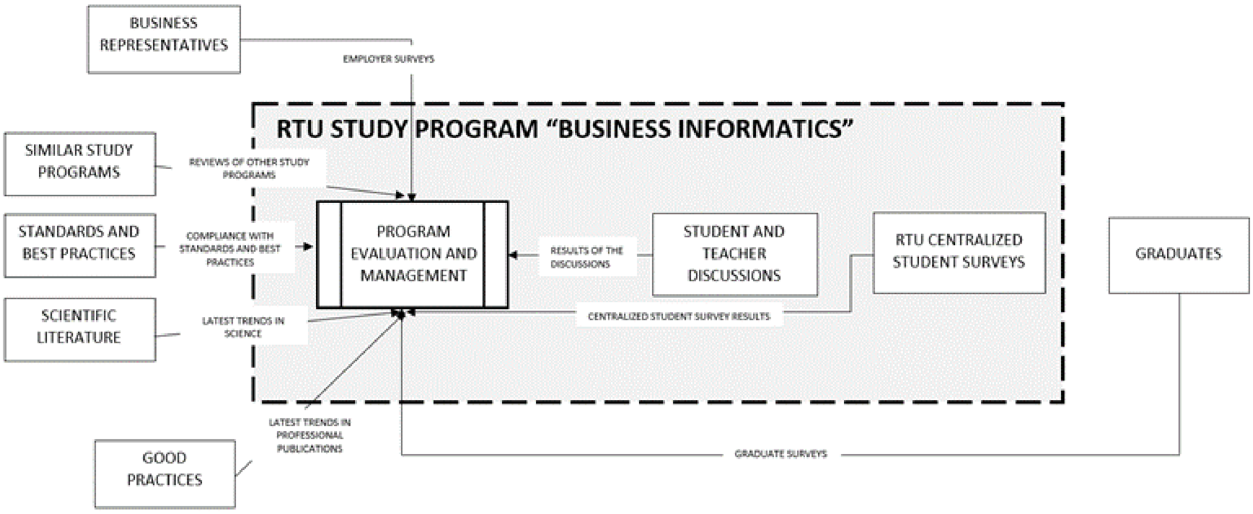
The compulsory study courses of the study programme “Business Informatics” form the systemic and engineering thinking, operation and research competencies necessary for the field of business informatics, providing students with essential theoretical knowledge in systems theory (DSP703

“Systems Theory”) and other theoretical foundations and research (DSP702 “Research Methods for Business Informatics”) and practical skills in solving business informatics tasks. The study courses of the compulsory part are mutually complementary and their learning outcomes, taken together, ensure the achievement of all the learning outcomes and aims of the study programme (Annex 8: Mapping of study courses for the study programme “Business Informatics”).

The compulsory elective part of the study programme allows students to acquire in-depth knowledge and skills in advanced areas of the field of business informatics and includes 4 thematic groups (Networking, Specific Software Applications, Enterprise Information Systems and Analytics), which helps in creating various knowledge concentrations. Students are invited to choose one study course from each thematic group, and students are currently offered two recommended sets of options (mainstream and cybersecurity concentration). These sets differ in study courses of two thematic groups. The mainstream includes such study courses as DPI700 “Storage Networking” and DSP705 “Artificial Intelligence in Business”, and the cyber security concentration, respectively, comprises the study courses DSP775 “Network Security Requirements” and DSP776 “Information Systems Security Engineering”. Cybersecurity related courses have been developed by professors at the Universities of Aalborg and Tartu specifically for the study programme “Business Informatics” so that they fit well with the compulsory part of the study programme and other compulsory elective courses, for example, in DSP776 “Information Systems Security Engineering” the same modeling methods are used as in DSP700 “Business Architecture and Requirements Engineering” and DSP706 “Business Process Management and Engineering”.

As already mentioned in Section 3.1.4, the study programme is implemented using several integrated study plans. Each plan provides a sequence of courses that promote effective succession of knowledge, for example, the course DSP708 “Advanced Data Technologies” is acquired before, or in parallel with, the analytics-related courses, such as DPI721 “Business Analytics” or DSP779 “Advanced Analytics and Knowledge Technologies”.

The constant compliance of the study content with the tendencies and needs of the field is achieved as a result of (a) lecturers' scientific activity, providing courses with always relevant content, (b) lecturers evaluating the results of the Master Theses, and (d) conducting formal surveys of graduates and employers. In addition, the academic staff and administration constantly monitor changes in similar study programmes at other universities (e.g., the University of Vienna, University of Rostock) as well as programme-related standards such as requirements engineering, business analysis and information security standards; and follow research related to business informatics.



The proposed changes in the study programme are discussed and approved by the Board of the

Institute of Applied Computer Systems, the Committee of the Study Field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science, as well as the Council of the Faculty of Computer Science and Information Technology.

During the reporting period, no significant changes have been made to compulsory courses (part A) as the combination of courses has proven its effectiveness and students have positively evaluated it. Due to the formal requirements set by RTU Senate, one of the courses, DPI721 "Business Analytics", has been moved to compulsory elective study courses (B1 – Field-Specific Study Courses). This transfer allowed including the study course DSP779 "Advanced Analytics and Knowledge Technology" in the programme, which increased the flexibility of the programme (Minutes No 12000-1.1/13 of the FSCIT Council meeting of 15 June 2018). The following changes have also been made to Part B1 of the programme:

- Since academic year of 2016/2017 the study courses DSP775 "Network Security Requirements" and DSP776 "Information Systems Security Engineering" have been included in the study programme, which allowed creating Cybersecurity concentration in the study programme. These changes have been made on the basis of a general increase in interest in the security of ICT solutions at enterprises. (Minutes No 12000-3.1/6 of the FSCIT Council meeting of 17 June 2016).
- The courses DSP710 "Software Applications in Education", DPI722 "e-Services in Education and Science", and RRI700 "Networking Technologies in Education", which were intended for the Educational Informatics concentration, were excluded from the study programme. This decision was made because, on the one hand, students did not show interest in these subjects, but on the other hand, a new organizational unit was established at RTU—the Faculty of E-learning Technologies and the Humanities, which focused on educating teachers in the field of IT. (Minutes No 12000-1.1/6 of the FSCIT Council meeting of 11 April 2022).
- The following study courses were also excluded from the compulsory elective part of the study programme: DST702 "Mobile, Grid and Ambient Networking", DOP702 "Customer Relationship Management and Social Networking Technologies" and PBM703 "Information Technology and Strategy", as their content began to overlap with other courses, and students did not show any interest in these courses during the last five years. (Minutes No 12000-1.1/6 of the FSCIT Council meeting of 11 April 2022).
- The study course DOP723 "Digital Transformation" (4 CP), according to the popularity of this topic in the industry, was included in the compulsory elective part of the study programme. (Minutes No 12000-1.1/6 of the FSCIT Council meeting of 11 April 2022).

The following changes have been gradually made in Part B2 of the study programme "Humanities and Social Sciences Study Courses":

- In academic year 2016/2017, courses PBM732 "Personal Career Development" and PBM429 "Leadership" were added. (Minutes No 12000-3.1/6 of the FSCIT Council meeting of 17 June 2016).
- In academic year 2018/2019, courses PBM707 "Entrepreneurial Finance" and PBM467 "Corporate Governance" were added. (Minutes No 12000-1.1/13 of the FSCIT Council meeting of 15 June 2018).
- In academic year 2021/2022, course PBM732 "Personal Career Development" was excluded from the programme. (Minutes No 12000-1.1/6 of the FSCIT Council meeting of 11 April 2022).

As the programme is implemented in cooperation with Riga Business School, the experience and recommendations of this institution play a key role in the selection of the range of B2 study

courses.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The study programme "Business Informatics" has been developed as a study programme with interdisciplinary features in cooperation with the University of Buffalo (USA) and IBM Corporation (International Business Machines Corporation). It has been implemented in English since academic year of 2010/2011. The study programme has good cooperation with business informatics researchers at the University of Rostock and the University of Vienna, where study programmes with this title are implemented. The Master degree in Business Informatics is also granted at Vienna University of Technology, the University of Utrecht, the IT University of Copenhagen and other universities.

The study programme has been designed as a niche programme in order to train specialists, who would be able to ensure an appropriate alignment between the rapidly changing business needs and the corresponding ICT solutions. In the field of business informatics, international conferences, such as *Perspectives of Business Informatics* Research (BIR) and *IEEE International Conference on Business Informatics*, have been held regularly for more than 20 years. As an alternative to the term "business informatics", the term "business information systems" is also used internationally, and conferences with this title are held and journals published. Researchers in both technology and social sciences are involved in business informatics research. RTU study programme "Business Informatics" corresponds to the branch of technology and uses research methods typical of engineering sciences, positioning in the fields of computer science and ICT research.

The aim of the study programme is to prepare professionals with expertise in systems thinking and engineering sciences who are able to use, select, develop and implement information and communication technology-based business development solutions, design internal and inter-organizational information systems and participate in relevant interdisciplinary and international projects.

The study programme ensures the topicality of the content of the study courses and compliance with the needs of the labour market in the field of business informatics and the latest achievements and findings in the field of computer science and ICT. Upon completion of the Master studies, the student must develop and publicly present the Master Thesis in the volume of 20 CP. The Master Thesis is an independent research, which is developed in close cooperation with researcher of RTU FCSIT and also researchers from other countries, taking into account the needs of the industry and current problems. The Master Thesis and its presentation demonstrate the student's ability to analyse, classify, compare the ideas presented in the scientific and technical literature in business informatics, to obtain, summarize, analyse and evaluate data using methods, methodologies, technologies, formulate problems, integrate the acquired knowledge and make assumptions about the possible innovative solutions to the problem. Within the Master Theses, students offer scientific innovations in business informatics. The developed Master Thesis should present research results that can be published. The degree is awarded on the basis of the results of a reviewed theoretical and/or practical research (Master Thesis) public defence and the examinations within the study

courses.

The fact that the awarding of a Master Degree in Engineering Science in Business Informatics is based on the developments of this branch of science, is also confirmed by the fact that the academic staff and students of the study programme regularly carry out research and participate in scientific projects. During the reporting period, the academic staff has participated in more than 20 projects, but students have participated in 4 projects on a contractual basis and in several other projects within the framework of their study course tasks or graduation papers (Annex BI1: The most significant projects of the teachers and students of the study programme “Business Informatics” (2013-2021)).

The themes of students’ Master Theses are related to the research topics of the academic staff and cooperation partners. Up-to-date research in the fields of requirements engineering, artificial intelligence, data analytics, information systems design and evaluation of ICT solutions has been conducted within the Master Theses. The themes of the Master Theses are described in more detail in Section 3.2.6. During the reporting period, approximately 30 articles have been published in internationally peer-reviewed conference proceedings or journals, the authors or co-authors of which are students of RTU study programme “Business Informatics” (Annex BI2: Publications of students of the study programme “Business Informatics” (2014-2021)).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

In the study programme, 38 CP are allocated to the compulsory part, 18 CP to compulsory elective study courses, 4 CP to free elective study courses and 20 CP to the Master Thesis. According to the content, the study courses can be divided into 3 groups: ICT study courses (e.g., DSP708 “Advanced Data Technologies”), business study courses (e.g., PBM423 “Business Ethics”) and integrated study courses (e.g., DSP706 “Business Process Management and Engineering”). Each study course has precisely defined learning outcomes, and students are introduced to the assessment system used in it. The programme is designed in such a way that various business and ICT issues are carefully integrated at different levels, namely both at the level of the study courses and at the level of the internal content of certain study courses.

Both Latvian and foreign students study at the study programme. There are two admissions per year. Latvian residents are also admitted for part-time studies. The summer admission full-time study plan provides one full semester for the Master Theses, which facilitates student mobility for the development of the Master Theses at other universities. In turn, in the winter admission, the study plan envisages the gradual development of the Master Theses.

In the study process, various methods are used to achieve the aims of the study programme and to accomplish the tasks:

- In order to develop students’ systemic thinking and ability to use systems theory in the development of solutions that promote the development of science and business, the principles of systems theory are used in practically all study courses of the compulsory part. Students are given lectures in systems theory, they undertake practical work in this study course, as well as see how principles and models of systems theory are used in other study courses.

- In order to integrate the knowledge of several business and ICT fields, the cooperation of lecturers of various RTU organizational units and other universities both at the level of development and teaching of individual study courses and within the study programme as a whole ensures valuable exchange of knowledge by participating in courses implemented by other lecturers. There is also active cooperation with lecturers of other universities, which allows enriching the knowledge in the use of different study methods, for example, lecturers from Aalborg University which is one of the leading universities in problem-based teaching; lecturers of Rostock University, which has advanced enterprise modelling facilities, and the University of Vienna, which organizes an annual business modelling summer school.
- The following methods are used to integrate the latest ICT achievements in the study process, to promote students' independent work, as well as to focus on technology work in groups:
    - The latest versions of technology (e.g., cloud versions of business process modelling tools) are used in study courses whenever possible.
    - Professionals in the field are involved in the implementation of study courses;
    - Students are provided with the opportunity to collaborate both directly and using modern teamwork tools, such as Microsoft Teams;
    - Student’s independent work is based on individual contexts of tasks and the student’s independent work takes up to 60% of the study time.
- The following methods are used to ensure the achievement of the planned learning outcomes of the programme:
    - Preconditions are defined for entering the programme regarding areas of knowledge that are necessary for successful acquisition of the programme and corresponding courses are provided before the start of studies or during studies (taken in C part of the programme).
    - For newly admitted students, studies begin with an orientation (kick-off) meeting, where students are provided with information on the content and sequence of study courses, the academic staff, the teaching methods used and administrative issues.
    - A code of conduct for the students of the programme has been developed, where the students get acquainted with the organizational culture of the study programme. This approach has proved its worth, as it promotes collegial cooperation among students of different nationalities and cultures, as well as between students and instructors.
    - Descriptions of all study courses are available in the RTU study management system (Moodle, ORTUS portal). This means that a student always has up-to-date information about the study course. At the beginning of the course, students receive detailed information about the course and requirements for successful completion of the course.
    - Each course has appropriate forms of presentation of study material as well as individual and group work. For example, in the course DSP706 “Business Process Management and Engineering”, a business process model is developed, while in the course DSP701 “Knowledge Management Systems”, the whole group of students forms a project team that develops a knowledge management system project.
- To prepare students for further PhD studies:
    - the didactic approach of the study programme is based on studies rooted in research, where students, in the study courses, get acquainted with the latest scientific

achievements;
    - students have the opportunity to participate in scientific projects, both by participating in them on the basis of an employment contract and by conducting research within the study courses, for example, students participated in data collection and analysis in the international project "*Adapting ICT Solutions for Active and Healthy Aging in the Baltic Sea Region*";
    - the programme includes the study course DSP702 "Scientific Research Methods in Business Informatics", which provides students with an understanding of the most important aspects of scientific work and prepares them for the development of the Master Theses;
    - In the analytics related study courses of part B1, students acquire skills in data processing technologies that are useful in scientific research;
    - in the development of the Master Thesis, the student should ensure its compliance with the status of scientific research.
- In order to best adapt to the changing requirements of the labour market and the development of various areas of business and ICT, the study programme is designed to be structurally flexible, providing good opportunities for change. The study programme has a stable, relatively constant set of compulsory study courses, while the compulsory elective part can be easily changed by maintaining the defined thematic groups of study courses. For example, during academic year 2016/2017, cybersecurity concentration was created by introducing two new study courses. In turn, the flexibility in terms of the study programme implementation is ensured by the integration of four study plans into a unified study course provision system, which allows both adapting to the needs of students and rationally using the infrastructure and time of instructors.
- Cooperation with similar or thematically related study programmes in other countries in the framework of ERASMUS and other initiatives is constantly developed. For example, such cooperation has led to the introduction of the cybersecurity concentration mentioned in the previous paragraph in cooperation with the academic staff of the Universities of Tartu and Aalborg; in cooperation with the Department of Business Informatics of the University of Rostock, study materials have been developed for the topic of information logistics in the study course DSP700 "Enterprise Architecture and Requirements Engineering"; and every year, the latest developments in business modelling methods and tools are explored and discussed at the Summer School of the University of Vienna (https://nemo.omilab.org/), where the world's leading researchers and practitioners in the field share their findings.

The study programme "Business Informatics" is implemented in accordance with RTU internal quality management system that functions according to the Excellence Approach approved by RTU Senate on 30 January, 2017 (minutes No. 606; see: https://www.rtu.lv/en/university/strategy/rtu-excellence-approach), as well as to RTU Quality Policy (minutes No. 612; see: https://www.rtu.lv/writable/public_files/RTU_quality_policy_of_rtu.pdf) approved on 25 September, 2017. The Quality Policy is aimed at completion of RTU mission and strategic goals – achievement of research, academic, infrastructure, and organizational excellence and recognition. The Quality Policy forms the framework for implementation of RTU Strategy, paving the way for development and improvement of research, studies and organization. The university Quality Policy is in agreement with the standards and guidelines of ENQA (European Association for Quality Assurance in Higher Education). RTU Excellence Approach and Quality Policy are mutually integrated documents, which stipulate that RTU uses EFQM (European Foundation for Quality Management) as a quality model.

The study programme follows the principles of total quality management, where each participant in the process is responsible for the quality of work: the instructor, the student and the support staff.

The implementation of the programme is organized by the head of the study programme.

The study programme is implemented full-time and part-time in a combined form in English, observing the requirements formulated in regulatory enactments, the basic principles of the study organization set by RTU and fulfilling all the requirements of the study courses. The course descriptions of the study programme define the set of relevant knowledge, skills and competences and their evaluation system, the learning outcomes are defined, for the achievement of which credit points are awarded. The procedure for the assessment of students' knowledge, skills and competences at RTU is determined by Senate Resolution of 27 May 2017 “On the Regulations for the Assessment of Learning Outcomes”, which complies with the basic principles and procedures for the assessment of education at the respective study level. A cumulative grading system is used to assess student achievement, with the final grade being made up of several components. The volume of full-time studies corresponds to 40 CP (part-time – 32 CP) per academic year and the amount of work of 40 academic hours per student in one study week, which makes up 1 CP. In Master studies, at least 40% of the workload is contact hours and up to 60% is independent work.

A large part of students of the study programme “Business Informatics” work at local and international companies in parallel to their studies. Therefore, the studies are organized in the evenings and the elements of e-learning have been used to create the most student-friendly conditions possible in the study courses and also to support the aspects of the student-centered approach described below.

1. Student involvement in the study process and content development

In accordance with the procedures developed by RTU, students have opportunities to provide regular feedback on the study curriculum. In addition to the formal processes (surveys), regular meetings of students and the head of study programme are in place to discuss the content and quality of the studies. Students also have the opportunity to contact the head of study programme or RTU Study Department at another time, where there is also a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process. Graduates of the study programme complete a questionnaire on the study process in general. Essential involvement of students in the improvement of the form and content of the programme implementation also takes place within the study course DSP701 “Knowledge Management Systems”. For example, students have conducted an audit of the study programme, developed proposals for additional knowledge relevant to the study courses, made proposals for mastering the result validation methods and, in collaboration with French ERASMUS students, developed a hybrid course delivery model that allows the programme to combine on-site studies with distance learning.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to the achievement of the learning outcomes of the study programme and the volume of the courses in credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (documents, presentations, video recordings, etc.). The Code of Conduct of the study programme stipulates that the student must inform the instructor if it is not possible to attend the lesson. This allows the instructor to modify the course and the Moodle settings accordingly, so that the student could learn the material at the most appropriate time, for example, a face-to-face lecture is recorded, the student is given the opportunity to individually fulfil an assignment, the deadline can be extended as well, etc.

3. Mobility

RTU offers a wide variety of opportunities to participate in international mobility which are available for Business Informatics students: 1) Erasmus+ programme; 2) Nordtek and Baltech programmes; 3) specialized cooperation programmes and 4) project financing. In the framework of exchange programmes, RTU provides students with an opportunity to study voluntarily at some foreign university for some period of their studies (normally, one academic term, but other mobility duration options also are possible). This opportunity has been used by several students of the study programme “Business Informatics”, developing their Master Theses at universities in Lithuania, Liechtenstein and France, as well as studying at universities in other countries, such as Portugal, for half a year. In addition to individual ERASMUS+ grants, students have also taken the opportunity to participate in international ERASMUS+ projects, where they have learned about the culture, work style and infrastructure of universities and companies in several other countries (e.g., Denmark, Poland, Germany, Spain, Turkey). Teachers of the study programme have also been involved in these projects, which has given them the opportunity to develop and learn new study methods. Furthermore, RTU regularly takes up opportunities of attracting visiting professors, who share their experience with students through individual guest lectures or the whole study course. Also, when meeting visiting professors at specially organized workshops, the academic staff involved in the programme can adopt good practices that visiting professors share. Mobility opportunities also are the means for advancement of academic staff qualification, wherein they gain experience at foreign universities. More detailed information about the attracted guest professors and mobility of the academic staff is given in Part 3.4.1. “Compliance of the qualification of the involved academic staff”.

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling which are available also for Business Informatics students. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs. For students of the study programme “Business Informatics”, studies take place in a multinational environment, which consists of both “permanent” students and ERASMUS students. This allows them to develop a variety of social skills, especially within a team or group. In order to develop students' social skills in a balanced way, different principles of student group organization are used: both forced groups (where students sometimes have to work outside their comfort zone) and freely chosen membership groups, where the student chooses which group or team to join.

5. Teaching and learning methods

Within the programme, various teaching and learning methods are implemented that are adapted by the academic staff and students to each particular situation. Classes are held in classrooms, computer classrooms and remotely. Cybersecurity related study courses are implemented mainly in e-mode, allowing students to choose the time for learning the topics relatively freely. Specially for the needs of the study programme, two free elective study courses (part C of the programme) have been developed as e-courses, in which students are completely free to choose both the time and the sequence of learning the topics. Students can receive consultations in accordance with the methodology “On Work Planning Guidelines for Academic Staff” approved by RTU Rector’s order, where it is stipulated that the instructor must provide consultations for every 25 students in the lecture stream in the amount of 15% of lecture hours. Pre-examination consultations are organized before the exams. If necessary, students can contact the lecturer directly outside the consultation hours by sending current questions in the form of messages or in the appropriate study course forum in the ORTUS system. Different combinations of teaching and learning methods are used in the study process, in which active learning dominates, for example the following combinations:

- presentation of theoretical material in the form of a lecture, use of material in group work in a common context, joint analysis of results, use of the material in an individual context;
- independent learning of the material, test, discussion of test results;
- acquisition of theoretical material from video collections, experiment under the guidance of a lecturer, discussion of results;
- structured literature analysis on the student’s chosen topic, simplified scientific article development, article upload in the conference management system, review of other students' articles, article presentation, and discussion (this method is used in the study course DSP702 “Research Methods in Business Informatics” and helps prepare well for Master Theses).

In several study courses, the problem-centered and student-centered approaches are combined, during the semester the student works on one problem situation of their own choice, for the solution of which the methods and principles acquired in the course must be used. This approach is particularly useful in cases where the student is able to solve a problem that corresponds to their direct job responsibilities at the company. The necessary confidentiality is also ensured in such situations. In the study process, skills to cooperate with students of other study programmes are also acquired. For example, in the course DOP701 “Portfolio Management Technology”, the study process takes place together with the students of the study programme “Information Technology”, but the compulsory elective courses of Part B2 take place together with the students of Riga Business School or other organizational units of RTU. Open access courses or their parts are used in the acquisition of certain topics, for example, in the spring of 2022, the study course DSP701 “Knowledge Management Systems” included the OpenHPI course “Sustainable Software Engineering” for students who worked on the project of environmental knowledge management system.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Embarkment. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classrooms. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools).

In the process of programme implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.) which are essential for Business Informatics students.

7. Academic staff competence development

The academic staff involved in the study programme are provided with regular opportunities to develop their methodological and didactical skills. RTU Methodological Conference is organized on the annual basis, various courses for the academic staff are regularly organized, learning aids for independent professional advancement are also available. The following courses/methodological seminars can be mentioned:

- 02.2019. Academic Integrity and Work with International Students;

- 12.2020. Organization of Remote Examinations;
- 02.2021 Implementation of Distance Learning;
- 03.2021 The Digital Age Student;
- 01.2022 Academic Integrity at RTU and FCSIT;
- 02.2022 Formative Assessment: with and without technology.

In cooperation with the University at Buffalo, academic staff can undergo internship at the USA It should be noted that the academic staff of the study programme “Business Informatics” also use the opportunities provided by various international projects and other open access courses offered by other universities to increase their competence.

8. Extracurricular student activities

Students at the programme are offered a vast variety of extracurricular activities:

- The management of the faculty actively support student self-government activities and encourages students to take part in them, thus letting them increase their autonomy, giving students an opportunity to implement their ideas, as well as the opportunities of supplementary studies outside lectures.
- Every student of the programme is offered opportunities to take part in extracurricular activities (sport teams, dance groups, choirs, etc.).
- Students are also engaged in scientific and research work on the relevant issues in the field, taking part in both local and international projects, resulting in their chances to participate in international conferences.
- The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Not applicable.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their

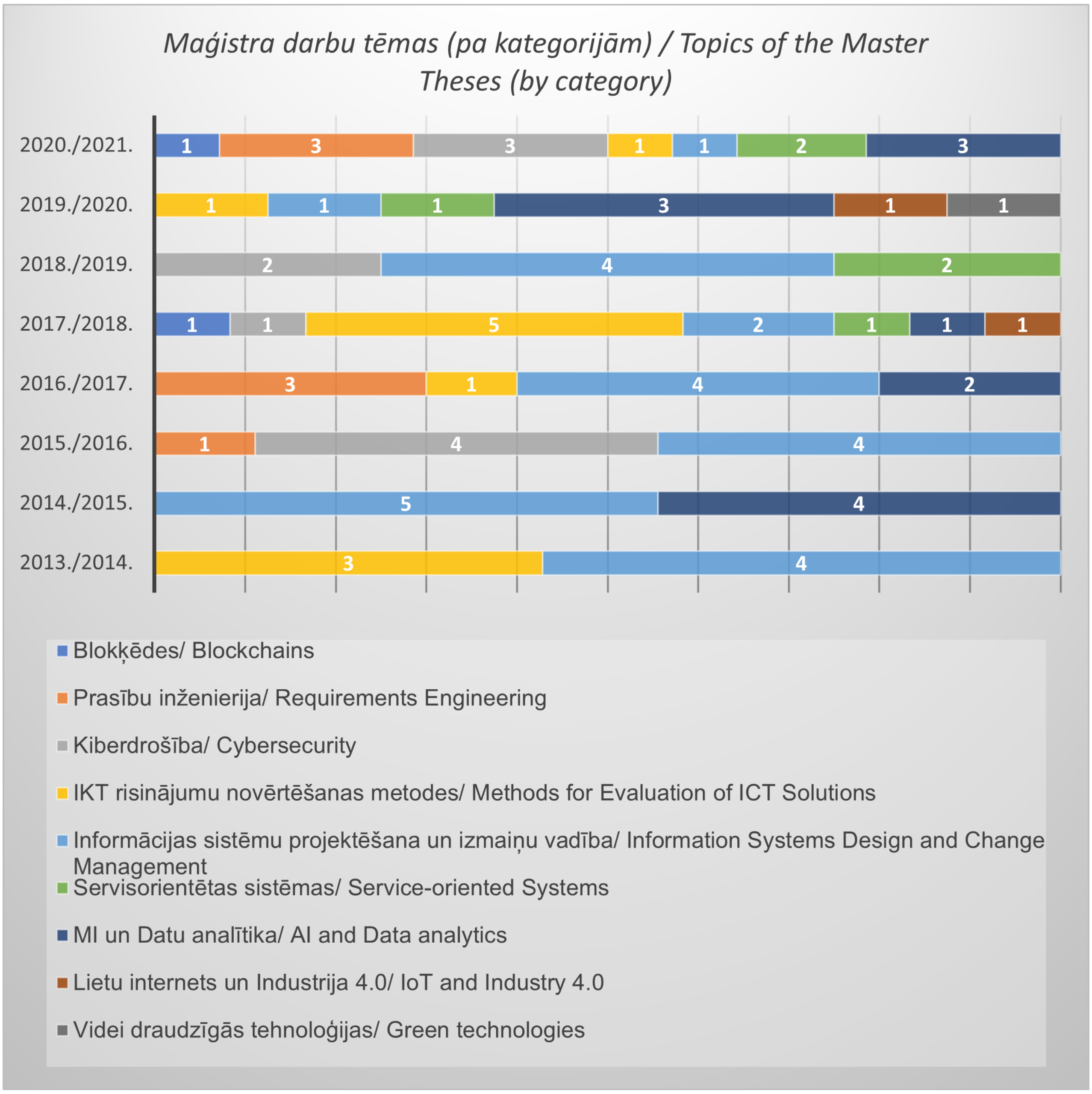
relevance in the respective field, including the labour market, and the marks of the final theses.

The topicality of research conducted within the Master Theses of the study programme “Business Informatics” is facilitated by the involvement of instructors and students in scientific projects (Annex BI1: The most significant projects of the teachers and students of the study programme “Business Informatics” (2013-2021)), the instructors’ industrial experience and the fact that most students work at advanced companies. The themes of the Master Theses reflect the scientific novelties relevant in the field and the labour market. Several Master Theses have been developed within the framework of international, scientific and ERASMUS+ projects (Annex BI1: The most significant projects of the teachers and students of the study programme “Business Informatics” (2013-2021)). The themes of the Master Theses can be divided into the following groups (however, it should be noted that this is not a canonical division, as the same work may correspond to several of the following thematic groups):

- *Information Systems Design and Change Management*, for example, Irina Zaborskaja developed the Master Thesis “Method for Developing Context-Aware Process Oriented Application Using BPMN 2.0.” within an international scientific project. This thematic group is the most represented and clearly shows the contribution of business informatics to digital transformation. In this group of themes, the student has either developed methods for designing ICT solutions, designs for these solutions, or methods for ensuring change management of ICT solutions.
- *Methods for Evaluation of ICT Solutions*, for example, Kaspars Zīle developed the Master Thesis “Feasibility Evaluation of Blockchain Application” and Ineta Būcena developed the Master Thesis “DevOps Adoption for Very Small Entities”, where they developed methods for evaluating ICT solutions.
- *Requirements Engineering*, for example, Anna Ivanova developed the Master Thesis “Requirements Engineering in Agile SCRUM Software Development”, where the attention is paid to the contexts and continuity of requirements engineering.
- *Artificial Intelligence (AI) and Data analytics*, which includes both the development of specific machine learning methods and the use of AI methods in solving certain tasks, for example, Gatis Špats developed the Master Thesis “Opinion Mining for Written Content Classification in Latvian Text”.
- *Service-oriented Systems*, that focus specifically on service-oriented developments, including currently very popular microservice architectures, such as Edgars Gaidels’ Master Thesis “Graph-based System Reliability Analysis in Microservice Architecture”.
- *Cybersecurity* – this topic is also represented, including the development of specific authentication and security management methods, for example, Justs Placāns’ Master Thesis “Security Risk Management in Corda-based Application for Capital Markets”.
- *Blockchains* – as this technology becomes popular, students regularly choose related topics, for example, Jānis Bauvars’ Master Thesis “Applicability of Blockchain Technology in Securities Settlement”.
- *IoT and Industry 4.0* have also become a regular area of interest for students of the study programme “Business Informatics”, such as Līga Vanaga's Master Thesis “IoT Technology Usage Opportunities to Personalize Insurance Services”.
- *Green Technologies* – only one work has been developed in this thematic group in the period of reporting, namely Julian Montes Franco Master Thesis “Simplified Model of an Information System to Calculate Greenhouse Gas Emission in Small and Medium Companies”, however

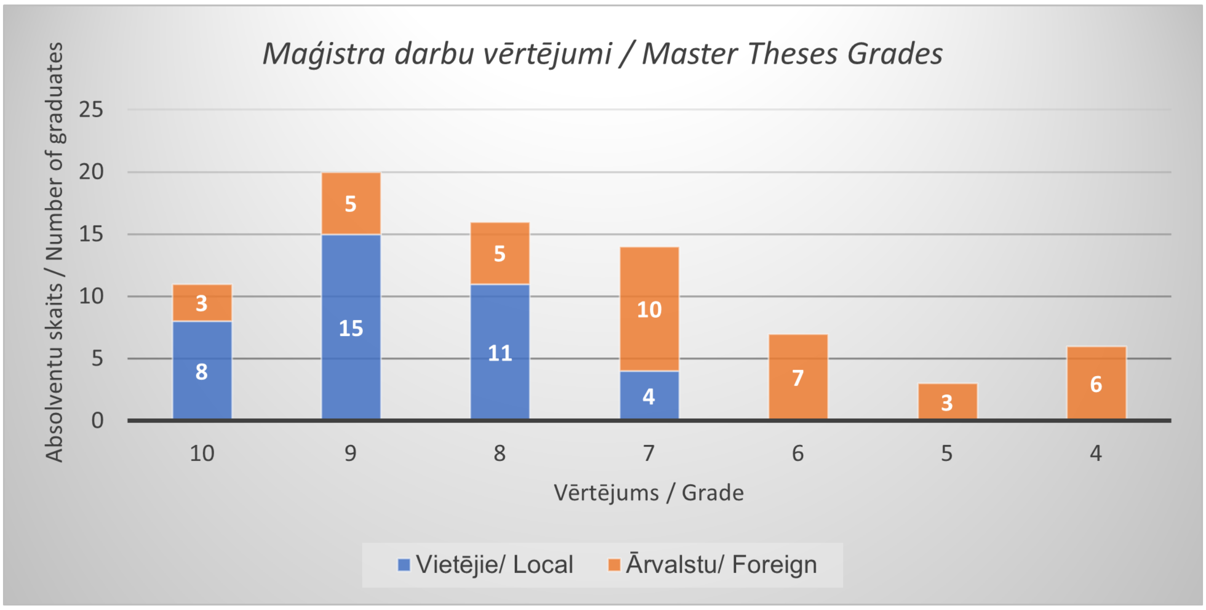
more theses in this area are expected.

The range of themes (by categories) by year is shown below (each thesis in the figure is assigned to only one thematic group).



During the reporting period (from 2013/2014 to 2020/2021), 38 Master students from Latvia and 39 foreign students defended their Master Theses. The distribution of Master Theses by grade in the reporting period is given below.

We can observe that, in general, local students have higher grades than foreign students. This is due to the high motivation and interest of local students in studies, which is lower for some foreign students. However, foreign students are also able to achieve high results, and they are not only representatives of countries such as Greece, but also students from, for example, Nigeria. Four students of the programme (2 local and 2 foreign students) completed the programme with honors during the reporting period. Eleven graduates are included in RTU Alumni Golden Fund.



The topicality of the research conducted within the Master Theses is confirmed by the fact that students often choose topics related to the problems at their companies, as well as the fact that in the Latvian ICT Thesis Competition ZIBIT, I. Būcena's thesis, "DevOps Adoption for Very Small Entities" received an appreciation prize in 2017, but E.Gaidels' work "Graph-based System Reliability Analysis in Microservice Architecture" got first place prize in its category in 2020.

A general list of themes by year and the grades obtained by the students are provided in Annex BI3: Thesis Topics and Evaluations of the Study Programme "Business Informatics" (2014-2021).

The scientific topicality of the Master Theses is confirmed by the fact that about 30 scientific articles on the topics developed in the Master Theses have been published in peer-reviewed conference proceedings and scientific journals, of which 20 articles are indexed in Scopus and five articles are indexed in WoS. It should be noted that some articles in Google Scholar have a fairly high citation, such as:

- The article *Zīle, K. Strazdiņa, R. Blockchain Use Cases and Their Feasibility. Applied Computer Systems, 2018, Vol. 23, No. 1, pp. 12-20*, was cited 85 times;
- The article *Bucena I., Kirikova M. Simplifying the DevOps Adoption Process. Joint Proceedings of the BIR 2017 pre-BIR Forum, Workshops and Doctoral Consortium co-located with 16th International Conference on Perspectives in Business Informatics Research (BIR 2017), Copenhagen, Denmark, August 28–30, 2017. CEUR Workshop Proceedings 1898, 2017*, was cited 51 times;
- The article *Da Silva V. G., Kirikova M., Alksnis G. Containers for Virtualization: An Overview. Applied Computer Systems, vol. 23(1), pp. 21-27, 2018*, was cited 26 times.

The list of publications of the students of the academic Master study programme "Business Informatics" is given in Annex BI2.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of

the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU provides study facilities appropriate to the study programme, consisting of computer classroom equipment, e-learning environment and bibliographic resources. The main place of the study process since 2021 has been RTU campus in Ķīpsala. Most of the study courses are provided in the premises of the Faculty of Computer Science and Information Technology on 10 Zunda Embankment. These premises provide a modern study environment with large auditoriums, open access computer classes and premises for students' independent work and extracurricular activities. The faculty is connected in a single complex with RTU Scientific Library, where there are rooms for group work and quiet reading rooms.

The study process within the study programme “Business Informatics” is mainly ensured by the academic and technical staff of FCSIT, as well as other organizational units of RTU (study courses in Part B2). Organizational units of FCSIT and RTU involved in the implementation of the study programme:

- FCSIT Institute of Applied Computer Systems,
- FCSIT Institute of Information Technology,
- Riga Business School,
- RTU Faculty of E-learning Technologies and Humanities,
- RTU Faculty of Engineering Economics and Management.

The FCSIF infrastructure is mainly used in the execution of the programme. The FCSIT is constantly updating and modernizing the equipment of the auditoriums and computer classrooms, following the development trends of the industry. Until 2020, the study programme “Business Informatics” made use of IBM’s infrastructure, which was maintained in the previous premises of FCSIT. Since 2021, the following material facilities have been used in the implementation of the programme:

- Auditoriums where lectures and practical classes take place. The study programme is mainly implemented in Ķīpsala Campus (except for the study courses of part B2), which has both FCSIT and RTU shared classrooms. Access for people with disabilities is provided. The available audiences are described in Part II, Chapter 3, Section 2.3.2 - Resources and Provision of the Study Field.
- Computer classes and computer laboratories of the Institute of Applied Computer Systems and the Institute of Information Technology, where software corresponding to the study courses is available. In total, the Institute of Applied Computer Systems has 5 specialized computer classes/laboratories with 150 computers that can be used for the students of the study programme “Business Informatics”; the Institute of Information Technology uses two specialized computer classes with the appropriate software for the study programme. Computer classes/laboratories allow instructors to use and provide technical support to students during the development of group projects, laboratory work and research. They also provide access to cloud services for use in the learning process, such as a variety of web-based business modelling environments and other software used in study courses.
- The FCSIT joint use Computing Center, which provides cloud computing resources. Students also have access to virtual computer classes for remote use of specific software. Students also have access to licensed Microsoft office software and software development tools.
- Virtualization services, which allow students to obtain the necessary computing resources with various software and infrastructure, including different types of Internet connection, for the performance of various tasks and experiments, for example, in the framework of the

development of the Master Theses.
- The National Research Centre of Information, Communication and Signal Processing Technologies established at the FCSIT in 2015 can also be used by students of the study programme “Business Informatics”.

Students of the "Business Informatics" study programme must be able to handle various software tools used in learning subjects: database management systems, enterprise modeling tools, data analysis tools, and other tools which made available by the aforementioned infrastructure. The use of the tools is involved in the achievement of practically all learning outcomes as it provides experience in working with different technologies (i.e. software tools and environments). The following learning outcomes should be noted in particular:

- Can, using appropriate technologies, model and analyse business processes, enterprise and business architecture, and information flows, as well as to design internal and inter-institutional information systems.
- Are able to follow advances concerning computer systems, communication technologies, and software and methods of their usage and to suggest various solutions and their combinations for raising competitiveness of enterprises and enterprise networks.
- Are able, using appropriate technologies, to develop enterprise improvement strategies, to plan analysis and change management projects, and define requirements for new products and services.

A sufficiently wide range of books and other informative resources corresponding to the academic Master study programme “Business Informatics” is available in RTU Scientific Library (the description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3 - Resources and Provision of the Study Field). The search for resources in RTU Scientific Library is provided by a search tool for aggregated resources. By order of the study programme “Business Informatics”, in the period from 2013 to 2021, 82 new books in the amount of EUR 4163.14 were purchased.

Part II, Chapter 3, Section 2.3.3 (Resources and Provision of the Study Field) lists the e-resource collections available in RTU Scientific Library. The Library is integrated with the centralized RTU portal ORTUS, so students may connect and access electronic learning materials at any time and place. The content of the following collections is most relevant to the specific nature of the study programme “Business Informatics”: ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink, ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost Web, ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate), learning materials repository Merlot, Latvian Standards Database (available only in the library premises). There is also an interlibrary loan and resource sharing system, ExLibris, where students can order books and journals that are available in other libraries.

The resources of RTU Scientific library are used in all study courses. The use of these resources is especially essential for achieving such learning outcomes as “students are able to participate in international scientific projects in the area of business informatics as well as to propose and lead scientific projects” and “students are able to follow advances concerning computer systems, communication technologies, and software and methods of their usage and to suggest various solutions and their combinations for raising competitiveness of enterprises and enterprise networks”, as well as in the development of master thesis to prepare students for doctoral studies.

Wireless Internet connection is available to students in all RTU premises, which enables students to study additional materials, participate in various interactive activities during the lectures, such as polls. The Institute of Applied Computer Systems also has the necessary equipment and software licenses for remote work with students, as well as the possibility to provide hybrid work, where some students are in the lecture room and some connect to the lecture remotely.

The centralized portal ORTUS (https://ortus.rtu.lv/) is used in the implementation of the study programme “Business Informatics”, it functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalogue of all IT services in the same place. For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programmes (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programmes, the study course register (https://stud.rtu.lv/rtu/discpub/list?english=true - public part), development of individual study plans, drafting of orders, study courses and training, input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in administration of the study process. On ORTUS portal students can see their financial information, make requests for documents (certificates, academic records, copies of the agreement, etc.). Academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

In order to ensure efficient study process, “Moodle” e-learning environment is used, where all binding information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-instructor communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc.

The “Moodle” e-learning environment and other ORTUS functions allow students to effectively organize their time by providing access to current information and significantly support the study process and the achievement of learning outcomes, among other things, they provide equal opportunities for both local and foreign students, as well as promote student self-organization in their studies.

Effective classroom resource management and planning of studies is provided by digitalization of premise and time schedules (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or member of the academic staff can see their schedule, specifying places, times, names of lecturers, classroom names and types of classes. To provide users with extra comfort, the system significantly facilitates planning and scheduling of classes, as well as optimizes premise occupancy and use efficiency.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

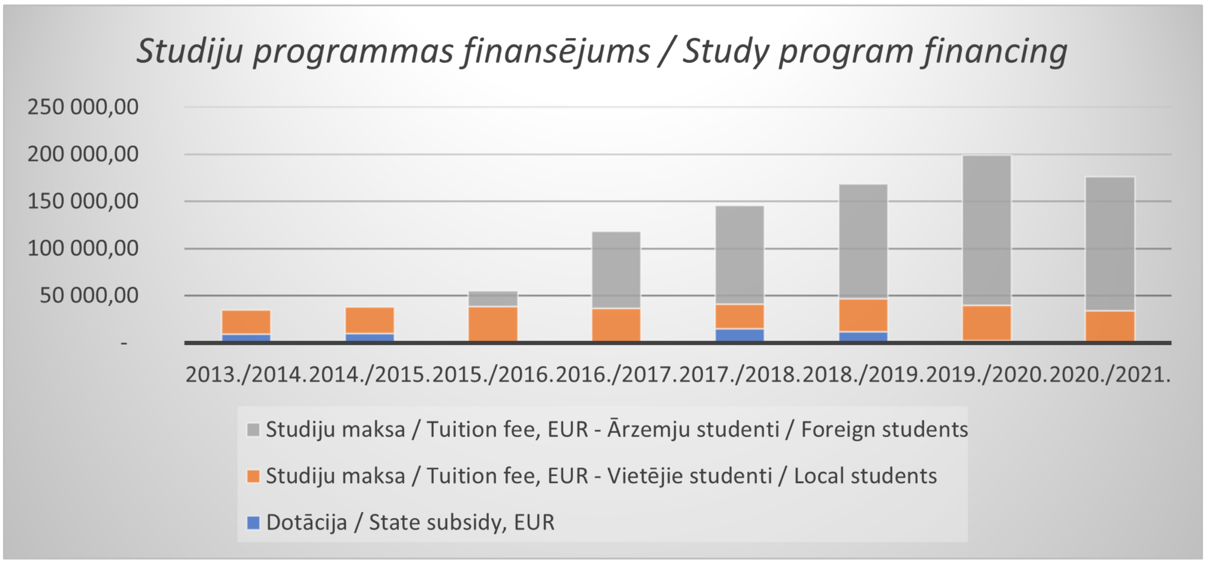
Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and technical facilities meet the conditions for the implementation of the study programme and promote the achievement of learning outcomes. The academic Master study programme “Business Informatics” is a tuition fee study programme. Since academic year 2021/2022, 12 state budget study seats have been allocated for local students. Tuition fee of the study programme will increase in academic year 2022/2023 due to the transition to a new infrastructure.

Study Programme Financing

Academic year	**State subsidy, EUR**	**Tuition fee, EUR**		**Total financing, EUR**	**Required expenses per 1 student, regarding the effective regulations, EUR**
		Local students	**Foreign students**		
2013/2014	9245,00	25519,00	*	34764,00	5799
2014/2015	9635,90	28187,45	*	37823,35	5799
2015/2016		38308,65	16794,93	55103,58	5799
2016/2017		36405,00	81 947,04	118352,04	5799
2017/2018	15216,28	26242,26	104246,89	145705,43	6061
2018/2019	11890,45	35063,01	121827,45	168780,91	6345
2019/2020	1992,49	37961,03	159127,65	199081,17	6608
2020/2021		34004,00	142514,35	176518,35	6694
* For academic years 2013/2014 and 2014/2015, the data on foreign students are not available. Taking into account the data on the number of students, it can be concluded that they were slightly lower than during academic year 2015/2016.					



As shown in the table and figure, the academic Master study programme "Business Informatics" in the reporting period has shown some increase in financing, which is mainly based on tuition fee income from foreign students starting from 2015.

Based on the 2015 "Study on Updating Study Cost Coefficients in Higher Education and Preparation of Proposals for Consolidation" conducted by the Ministry of Education and Science, as well as RTU empirical calculations and in accordance with expert assessments, in order to ensure the profitability of the study programme, RTU stipulates that the academic Master study programme must have at least 19 students per year. The number of students at the study programme has recently exceeded 25 students by year, so the study programme is recognized as profitable. According to the study programme "Business Informatics", part-time students do not have to be considered separately from full-time students, because they are included in the overall study process (part-time students have one class less per week than full-time students and they study for half a year longer but participate in the common study process.)

Distribution of funding among cost items within the study programme "Business Informatics".

Cost item	**Sum, EUR**	**%**
Average actual costs per 1 student, EUR	*3199,42*	*100*
Remuneration	1438,5	45
Employer's SSIC, compensations and benefits	341,08	11
Business trip expenses	12,68	0
Payments for services	76,20	2
Materials, energy resources, inventory	11,48	0
Purchase of books and magazines	147,06	5
Purchase and modernization of equipment	0,06	0
Administration costs*	435,22	14

Infrastructure costs*	558,9	17
Social security costs	178,24	6
* Administrative costs include the Rectorate's services, services of the Information Technology Department, Project Management and Development Department, Administrative Department, Department of Public Affairs, Department of Quality and Risk Management, as well as contributions to RTU reserves. Infrastructure costs include all payments related to the maintenance of buildings and premises, provision of IT systems, and operation of service vehicles.		

From the start of the study programme until 2020, the study programme “Business Informatics” made use of the IBM infrastructure free of charge. When moving to new premises, this infrastructure will no longer be available (it has become obsolete, and its renewal is not possible because IBM's activities in Latvia have significantly decreased). Financial resources from various projects were also attracted to the study programme, which are not reflected in the indicated costs.

Starting from 2021/2022 the costs of the study programme “Business Informatics” will not differ significantly from FCSIT academic Master study programmes, such as “Computer Systems” and “Information Technology”.

Detailed information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the minimum number of students required for the study programme is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study programme”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

5 professors (3 in the study courses included in Parts A and B1 and 2 – Part B2) and 5 associate professors (3 in the study courses included in Parts A and B1 and 2 – Part B2) are involved in the implementation of the study programme. Their qualifications meet the needs of the study programme to the fullest extent. Qualification of the academic staff implementing the study programme fully corresponds to the study programme implementation conditions and requirements of the regulatory enactments, and ensures achievement of the study objectives and expected learning outcomes (see the CVs of the academic staff).

The total number of teaching staff involved in the study programme in parts A and B1 is 13. Since students have compulsory elective study courses (part B), each student studies with 9-12 teaching staff during the study programme, depending on the chosen compulsory elective study courses and not counting compulsory free study courses. In part B2, 9 teaching staff members are assigned to the study programme for a total of 10 study courses, but since the student chooses only one or two study courses, the total number of teaching staff per student is equal to the number of teaching staff assigned to the specific course(s). The study courses of part B2 are not taught specifically for business informatics students. Here, students join business study student groups in order to further develop their ability to cooperate with representatives of the business environment, which is necessary in the selection, design and development of ICT solutions. Therefore, the teaching staff of the B2 part study courses are listed here separately.

The study programme involves 15 PhD degree holders, and all the academic staff responsible for the study courses hold a PhD in the corresponding field. Short biographies of professors and associate professors involved in the implementation of the study programme are given below.

Prof. Jānis Grundspeņķis - Dr.habil.sc.ing., an academician, one of the few professors of systems theory in the world, delivers the course DSP703 “Systems Theory” (Part A - Compulsory study course) within the study programme. His most recent research in this field is related to the analysis of the complexity of concept maps from the point of view of systems theory and the use of ontologies in competence management, which has been studied in cooperation with Baltijas Datoru akadēmija Ltd. J. Grundspeņķis had been the Chair of the Promotion Council “RTU P-07”, is the author of more than 200 scientific publications; has received several RTU and Latvian state awards for high quality scientific and pedagogical work.

Prof. Jānis Grabis – Director of the Institute of Information Technology of RTU Faculty of Computer Science and Information Technology. A co-author of over 125 “Scopus” indexed international scientific publications about the issues related to enterprise integration, optimization and digitalization of project management and business processes (“Scopus” h-index is 12). Prof. Grabis worked as a researcher or a visiting professor at the University of Michigan-Dearborn and Stockholm University; has led and participated in more than 12 scientific research projects, including EC framework programmes, ERDF practice-oriented research, LCS (Latvian Council of Science) Fundamental and Applied Research Programme, projects of EEA and Norway grant and State Research Programme, as well as in more than 10 contracted works in cooperation with the companies. Head of the Bachelor and Master study programmes in Information Technology and PhD programme in Computer Science and Information Technology. In 2021 was recognized as RTU Academic Staff of the Year. He delivers two study courses of parts A and B1 within the study programme “Business Informatics”.

Prof. Mārīte Kirikova – Professor of Information Systems Design at the Department of Artificial Intelligence and Systems Engineering, author of more than 200 scientific publications in the thematic areas of requirements engineering, business process engineering, service-oriented systems and knowledge management (Scopus h-index 8). She raised her qualification in Sweden, the USA, Denmark, the Netherlands and Austria. The organizer and member of programme committees of several scientific events in the field of business informatics. Co-editor of several internationally recognized conference proceedings. She delivers two study courses of part A and participates in the delivery of two more study courses of Part A within the study programme “Business Informatics”.

Prof. Marina Platonova within the study programme “Business Informatics” delivers the study course ETH702 “Communication and Presentation Skills” (Part B2). M. Platonova's scientific publications are related to terminology and terminotics, translation studies, language for specific purposes, communication theory, digital humanities, communication rhetoric, presentation skills and other research issues. Since 2016 she has published 28 articles (including 6 on communication issues) in international scientific journals and conference proceedings. She works in the EUt+ sub-projects SMARTI and ELARA, participates in the state research project “The Latvian Language” and “Digital Resources of the Humanities: Integration and Development”. She is a member of several Latvian and international associations and commissions, as well as a member of the editorial boards of several conferences and journals.

Prof. Karine Oganisjana – Dr.paed. Professor and leading researcher at RTU Faculty of Engineering Economics and Management, delivers the study course “Pedagogy” (Part B2). She is an expert of the Latvian Council of Science in two fields of social sciences: Economics and Entrepreneurship and Educational Sciences. She has academic and scientific work experience at

RTU since 2012. She has higher education in physics, English, secondary and higher education pedagogy; defended the PhD Thesis “Promotion of Students' Entrepreneurship in the Study Process” in 2010. Extensive international and interdisciplinary professional interest and research experience (Scopus h-index 7). Dr.paed. K. Oganisjana is the author and/or co-author of 2 textbooks, 4 monographs, 4 collections of tasks in physics, one design sample, as well as a scientific editor of one monograph. Since 2011, she has been actively leading professional development courses for teachers and education specialists in all regions of Latvia, as well as consulting and developing solutions to pedagogical problems within the framework of projects of the National Education Content Center, the State Education Quality Service, the Ministry of Education and Science, as well as Cabinet of Ministers. Karine Oganisjana is one of the founders and members of the board of the VITAE Institute for Lifelong Learning and Culture.

Assoc. prof. Ērika Nazaruka – Dr.sc.ing., Corresponding Member of the Latvian Academy of Sciences. In relation to the study course DPI704 "Quality, Risk and Security Technologies" (Part A) delivered by Ē. Nazaruka, it can be noted that the scientific publications are related to the formalization of the software development process. Formalization tools allow reducing certain risks associated with project development by implementing quality management activities at all stages of development. In order to improve her qualification in security issues, the course “Palo Alto Networks Online Instructor Faculty Training” organized by Palo Alto Networks – Cybersecurity Academy was completed and the certificate of Palo Alto Networks Cybersecurity Academy Instructor was obtained.

Assoc. prof. Aleksejs Jurenoks – Dr.sc.ing., Head of the Department of Software Engineering. In the academic Master study programme “Business Informatics” A. Jurenoks delivers the study course DLP700 “E-business Solutions” (Part A). Competences in the field of e-business solutions were obtained during the last three years by implementing the company’s e-projects and 2 ITCC projects, as well as supervising students' graduation papers. During the last six years, 15 articles were published, 2 of them related to business process automation issue; in 2022, he attended a professional development programme “Electronic Commerce for Business Development (with prior knowledge)” in the amount of 160 hours.

Assoc. prof. Gundars Alksnis – 2013–2015 Dr.sc.ing. G.Alksnis participated in the project “Service Routing Technologies in Workflows”, which included research of service-oriented solutions. He has supervised a number of students' Master Theses related to aspects of service orientation. The courses DSP707 “Service Science, Management and Engineering” (Part A) and DPI700 “Storage Networking” (Part B1) delivered by G. Alksnis have been implemented since 2011. These courses are updated annually to reflect the latest research and industry trends in the field. As a member of the programme committee, G. Alksnis has been a reviewer at several international scientific conferences and has chaired conference sessions.

Assoc. prof. Tatjana Hramova – research interests and activities are mainly in the field of humanities. She is interested in understanding how different semiotic regimes are intertwined in meaning. She also explores how language is used to organize and maintain social groups, to construct meaning and identity, to coordinate behavior, to mediate power, to create change and knowledge, which is also directly linked to rhetoric. As rhetoric is directly related to communication studies, T. Hramova believes that her research interests contribute to the teaching of the study course ETH702 “Communication and Presentation Skills” within the study programme “Business Informatics” (Part B2).

Assoc. prof., Dr.sc.admin. Antra Roskoša – areas of scientific activity: educational management, applied linguistics, pedagogy. The most characteristic features of the research: 1. Interdisciplinary research (educational management, pedagogy, applied linguistics); 2. Several studies (9) were conducted in collaboration with faculty from another university; 3. Part of the research (4) was conducted in cooperation with RTU academic staff; 4. Seven articles are indexed in the Web of Science database; 5. The main focus of the research is students (mainly RTU, but also other, both local and foreign students) who help contribute to the course ETH702 “Communication and Presentation Skills”.

In addition to the above-mentioned academic staff, a significant contribution to the study programme is also provided by:

Assist. prof. Ilze Birzniece – Dr. sc.ing., the responsible instructor of the study course DSP702 “Research Methods in Business Informatics”, and study courses related to the analytical thematic group. Competences in the field of data analysis and knowledge retrieval were supplemented during the last two years by participating in three ITKC projects and supervising students’ graduation thesis. In the last six years, 10 articles were published, 7 of which were related to information retrieval, data mining and analytics in various fields of application. In 2021, she attended RTU professional development programme “Data Analysis and Reporting with Python” in the amount of 160 hours. She also co-authored an international publication on academic integrity.

Assist. prof. Ilze Andersone – Dr.sc.ing., is responsible for the study courses DSP708 “Advanced Data Technologies” (Part A) and DSP705 “Artificial Intelligence in Business” (Part B1). In the last three years, the assistant professor developed her knowledge in the field of artificial intelligence and its applications by participating in several ITKC projects (in cooperation with Mobilly, HELMES, Computer Science Center). Over the past six years, she has published seven papers on the applications of Artificial Intelligence (AI) models in data analysis and AI robotics applications. Three more articles on AI applications in data analysis have been accepted for publication.

The following employees of RTU and guest lecturers also significantly contribute to the study process:

Lecturer Ainārs Auziņš – has completed internship at the University of Buffalo, he participates in the course DSP708 “Advanced Data Technologies” (Part A).

PhD student, researcher Arnis Staško together with prof. Jānis Grundspeņķis implements the study course DSP703 “Systems Theory” (Part A) and together with the visiting professor Raimundas Matulevičius (University of Tartu) implements the course DSP776 “Information Systems Security Engineering” (Part B1), based on the book published by R. Matulevičius and the developed study materials.

Guest Professor Jens Myrup Pedersen from Aalborg University has been cooperating with the study programme “Business Informatics” in various ERASMUS + projects for more than 10 years and since academic year 2016/2017 has been implementing the study course DSP775 “Network Security Requirements” (Part B1). He is the Chair of the Cyber Security Group at Aalborg University and is involved in several Danish and European projects on cybersecurity; supervises Master and PhD Theses. In addition, he is a member of the Board of the Strategic Cyber Competence Center and a member of the Danish Cyber Security Council.

Dr.sc.ing., Mg.oec. Renāte Strazdiņa has been cooperating within the study programme “Business Informatics” since its establishment and participates in the implementation of the course DPI704 “Quality, Risk and Security Technologies”. Renāte Strazdiņa is the head of the Microsoft EMEA Digital Transformation and Innovation Advisory Group. Since joining Microsoft, she has only worked as an industry guest lecturer in the Business Informatics programme.

In addition to the instructors mentioned above, other lecturers also participate in the implementation of the study programme, i.e., the Head of Riga Business School (RBS), assistant professor Jānis Grēviņš, Deputy Director of RBS assistant professor Claudio Andres Rivera, assistant professor Raimonds Lieksnis, and others.

During the reporting period, Business Informatics students have also had various classes in cooperation with other (not mentioned above) lecturers and professionals in the field. For example, in October 2013, as part of the study course DSP706 Business Process Management and Engineering, students participated in an international business process modelling session organized by the German company HORUS; in the spring of 2015 and 2016, students were offered an elective course prepared by Dmitrijs Pozdnakovs (Accenture) on SAP workflow management; during the reporting period, guest lecturers from Lithuania (Saulius Gudas), Bulgaria (Asen Bazhikov), Jordan (Omar Al-Hujran) and other countries and Latvian universities (for example, Kaspars Osis from Vidzemes Augstskola), as well as representatives of industry, such as, Kārlis Vītols from Scandic Fusion, Māris Svilāns from Infotrust SAP Lumira, Baiba Apine from PricewaterhouseCoopers and others, have participated in various study courses. It should also be noted that in the summer of 2019, several Business Informatics students took the opportunity to listen to a lecture on design science research by Alan Hevner, a distinguished professor at the University of South Florida (USA).

All instructors involved in the study programme are highly qualified, with experience in international cooperation and scientific projects, and constantly improve their qualifications that correspond to the courses that they deliver. More than half of the instructors have experience in the industry. There is one LAS (Latvian Academy of Science) academician, two LAS correspondent members and six LCS (Latvian Council of Science) experts in the programme. Several instructors also have experience working at universities in other countries. The qualification of the instructors involved in the implementation of the study programme “Business Informatics” fully complies with the conditions for the implementation of the study programme and the requirements of regulatory enactments.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The study programme “Business Informatics” was developed in 2009 by a group of nine instructors using advanced requirements engineering methods. Most of the members of this group have become instructors of the study programme and are still engaged in the implementation of the programme. During the reporting period, (since 2013) there have been several significant changes in the composition of the academic staff:

- In the study course DLP700 “e-Business Solutions” prof. Leonid Novickis has been replaced after his death in 2017 by assoc. prof. Aleksejs Jurenoks, the Head of the Department of Software Engineering, who has been participating in the implementation of the course since 2012. Since A. Jurenoks was previously involved in teaching the study course, this replacement did not cause problems for the students; also, very positive feedback from students has been received about the work of A. Jurenoks.
- In the study course DPI704 “Quality, Risk and Security Technologies” prof. Uldis Sukovskis has been replaced by his younger colleague, assoc. prof. Ērika Nazaruka. Ērika Nazaruka performs her work very responsibly, maintaining the high quality of study course teaching and cooperation with industry representatives. In addition, Ē. Nazaruka is also very successfully participates in advicing and reviewing master theses in the context of this study course.

- The study courses DPI721 “Business Analytics” and DSP779 “High Level Analytics and Knowledge Technologies” (included since academic year 2018/2019) are delivered by Dr.sc.ing., assist. prof. Ilze Birzniece, who during her PhD studies helped with the implementation of the study course DPI721 “Business Analytics” (now being a responsible instructor of the course). Before she became a responsible instructor of this study course, there was a large number of industry representatives involved and the study course content sometimes became too fragmented. I. Birzniece has managed to integrate and balance the study course topics well, and in recent years we have received positive evaluations from students for this.
- In the study course DSP705 “Artificial Intelligence in Business” Dr.sc.ing. Egons Lavendelis has been replaced by Dr.sc.ing., assist.prof. Ilze Andersone. Ilze Andersone has been cooperating with E. Lavendelis for a long time in teaching artificial intelligence study courses. The replacement of the teaching staff did not bring negative changes in the quality of the study course.
- PhD student Arnis Staško is involved in the implementation of the study programme, who delivers the study course DSP703 “Systems Theory” and the study course DSP776 “Information Systems Security Engineering” introduced in academic year 2016/2017. Arnis Staško is a doctoral student and at the same time an industry representative with knowledge suitable for teaching both study courses. His work has received good reviews from students and, as well, from Prof. J. Grundspeņķis, who is responsible for the study course DSP703 “Systems Theory” and from Tartu University Prof. R. Matulevičius, in cooperation with whom the study course DSP776 “Information Systems Security Engineering” is implemented.

The core of the study programme’s team is prof. Jānis Grabis, Jānis Grundspeņķis, Mārīte Kirikova and assoc. prof. Gundars Alksnis. Young talented instructors are gradually being attracted in the implementation of the study programme, thus taking care of its sustainability. As mentioned above, two new associate professors, two assistant professors and one PhD student have joined the programme (parts A and B1) during the reporting period. Other temporal changes in the personnel involved are not mentioned here. The composition of the academic staff delivering the study courses of Part B2 has also changed over the years, while continuously in cooperation with Riga Business School. In general, the mentioned changes have allowed ensuring high quality studies. Positive feedback has also been received from students about the newly involved academic staff. More information about the academic staff involved in the programme is provided in Section 3.4.1.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

During the acquisition of the programme, each student collaborates with 9–12 academic staff members, depending on the chosen compulsory elective study courses and not including free elective study courses. In parts A and B1 of the study programme, the average number of students and instructors holding a PhD degree in the reporting period is approximately 6:1. Part B2 of the programme is not taken into account here, because Business Informatics students join the students of other study programmes in these courses.

As mentioned above, the study programme “Business Informatics” has been created as a result of the work of a team of instructors. The teamwork style has been maintained in the later years of the programme development. Most of the instructors are personally acquainted. They cooperate within the study courses where more than one instructor is involved in the delivery of the course, have regular formal and informal discussions with other colleagues about the success of the students and what they perceive as problems and how to help them to solve these. Several teaching staff members are involved in more than one study course as responsible or a helping instructors. This gives an additional opportunity to assess the course mutual compliance and compliance to study programmes purposes. The teaching staff members of the study programme “Business Informatics” cooperate also in the implementation of educational and scientific projects (the most important projects can be seen in Annex BI1), as well as in the organization of various scientific conferences and seminars. In addition to these forms of cooperation, the following mechanisms for promoting cooperation should also be mentioned:

1. Discussions after the Master Theses’ pre-defence and Master Theses' defence.
2. The group of instructors involved in the implementation of the study programme “Business Informatics” is created in the MS Teams environment and Outlook, which are used to disseminate information and discuss important issues.
3. Shared in the MS Teams environment documents are used, such as a document in which lecturers note changes in their courses so that other lecturers are aware of them and can discuss these changes; and a document proposing themes of the Master Theses.

These forms of cooperation ensure integrity of study courses in the study programme.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DMB0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DMB0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DMB0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DMB0(45526)_AIP_atzinums250stud_Biznesa_informatika.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DMB0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DMB0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMB0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_DMB0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DMB0(45526)_Kartejums_LV_Mapping_ENG.pdf	P08_3.2.1_DMB0(45526)_Kartejums_LV_Mapping_ENG.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DMB0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DMB0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DNB0(45526)_StudyCoursesdescr_ENG.zip	P10_DMB0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Computer Systems (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Systems*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Egons*
Surname of the study programme director	*Lavendelis*
E-mail of the study programme director	*Egons.Lavendelis@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*67089548*
Goal of the study programme	*The aim of the study programme is to prepare specialists with deep knowledge in computer science, software engineering, computer systems development theory, database technologies, programming languages, software development environments and artificial intelligence, as well as with ability to participate in software development project, fulfilling different (including manager) roles and complying with IT industry standards and professional ethics. To prepare students so that after graduation they could start working in the university, scientific research organizations, fulfil professional duties at IT companies, as well as continue studies at Doctoral study programme.*
Tasks of the study programme	*Study programme tasks are the following:* *- To provide deep knowledge in computer science, focusing on software engineering, computer system development and system analysis, as well as in artificial intelligence methods and modern database technologies.* *- To provide knowledge about the recent findings in computer science that provides the basis for creative thinking.* *- To develop students' scientific analysis capabilities, pedagogical skills, and ability to solve problems independently, to continue studies in the doctoral study programme and to promote their involvement in scientific problem solving.* *- To strengthen students' abilities of independently improving their professional knowledge and skills.* *- To develop students' skills to professionally work with complex computer systems' development environments and tools, as well as critically evaluate them and choose the most appropriate for solving different tasks.* *- To provide knowledge and skills that are necessary for project and team management.* *- To improve students' oral and written communication skills as well as to improve students' skills in team work.* *- To improve scientific research skills by developing Master Thesis.*

Results of the study programme	*Graduates of this study programme will be: - able to independently define and critically analyze scientific and professional problems; - able to carry out scientific research, define and justify its results; - able to professionally adapt, to acquire new research methods and technologies; - able to professionally draw up, submit and present scientific research results; - able to participate in research projects and assist in pedagogical work; - able to prepare scientific papers and conference presentations; - able to professionally use complex environments and tools for systems analysis and modeling, and/or software development tasks; - able to choose the appropriate software products, tools and methods (including artificial intelligence methods) for solving problems; - able to implement and apply theoretical concepts of computer science; - able to organize and manage a group of software developers, analyze work results; - able to improve independently their competencies; - able to perform innovations in software engineering industry.*
Final examination upon the completion of the study programme	*To receive the academic degree of Master of Engineering in Computer Systems, students must accomplish the syllabus and work out and defend their Master Thesis. The volume of the Master Thesis is 20 credit points, which are divided as follows: 4 credit points during the first study year and 16 credit points during the second study year. Master Thesis must be defended publicly in front of thesis definition committee where the student presents his/her thesis and answers the questions asked by the committee, reviewer and general audience. A reviewer with Doctoral degree is appointed for the evaluation of the paper. The guidelines for contents and public defence are laid out in "Instructions for working out Master Paper" published by the Institute of Applied Computer Systems.*

Study programme forms

Full time studies - 2 years - latvian

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree of Engineering Science in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering, or Bachelor Degree of Natural Sciences in Computer Science, Mathematics, Physics, or comparable education*

Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Computer Systems*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*
Admission requirements (in English)	*Bachelor Degree of Engineering Science in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering, or Bachelor Degree of Natural Sciences in Computer Science, Mathematics, Physics, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master Degree of Engineering Science in Computer Systems*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

As part of the evaluation procedure of the study field, the educational classification code of the study program was changed to 45526 – other engineering sciences. This change was made in view of the fact that the study program “Computer Systems” basically covers computer systems development technologies and relevant research results in information technology. A study of various sources, including university curricula in the European Union and other countries, reveals that today information and communication technologies is a branch of engineering sciences that aims to develop and research methods, tools, approaches, technologies and technical solutions to solve practical problems in order to improve people’s living conditions. This distinguishes information and communication technology as an engineering discipline that uses scientific knowledge to solve practical and technical problems in order to create objects that do not exist in nature, from natural science, which studies the patterns and phenomena that exist in nature.

In accordance with the Cabinet Regulation No. 240 of 13 May 2014 “Regulations on the State Standard of Academic Education”, the volume of program has been changed from the historical 81 CP in 2013 to 80 CP in 2022. These changes in the study program were made by reducing the amount of the compulsory part from 37 to 36 CP and excluding the study course “Basics of Labor Protection”.

Given the increasing number of Bachelor study programs in computer science and information technology in Latvia and worldwide, the admission requirements have been made more flexible to enroll all students with the appropriate background knowledge. The prior education requirements are formulated as follows: Bachelor of Engineering in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering, or Bachelor of Natural Science in Computer Science, Mathematics, Physics or an equivalent higher education qualification. In addition, it is required that the student has completed study courses in the following study fields: Programming (2 CP), Databases (2 CP), Mathematics (3 CP), Fundamentals of Systems Analysis and/or Artificial Intelligence (2 CP). If the candidate has not completed study courses in the respective study field at least in the specified volume, they must be completed in addition to the study program before entry to the program or during the first semester of studies.

Given the level of the study program (Master), it is implemented in only one location - Riga, where the appropriate academic staff is available and research in the relevant field is also carried out.

Given the dynamic nature of the field of computer science and information technology, the content of the study program curriculum and of each study course is regularly reviewed. At the level of the study program, a regular assessment is made of the relevance of the existing study course to the current situation in the field and research area. If an existing study course is found to be outdated or for any other reason does not fulfil its intended role in achieving the objectives of the study program, it is replaced by a new study course or its curriculum is significantly changed. At the level of study course, each responsible instructor reviews the curriculum of their course to ensure that it is up-to-date with the latest technologies and trends in the field. When significant changes are made to a study course, they are first reviewed by the Institute of Applied Computer Systems Council so that all organizational units implementing the study program are aware of the changes and so that consistency between study courses within the program can be ensured.

Based on Section 6 of RTU Internal Code of Student Conduct, RTU Code of Academic Integrity and RTU Study Department's guidelines "Breach of Academic Integrity and Breach Consideration Procedures", since 2018 an enhanced plagiarism control has been introduced for graduation papers written in English and since 2021 for all study papers. In 2019, a procedure for reviewing academic integrity violations was adopted (FCSIT Council Decision No. 12000-1.1/9 of 14 June 2019 "On the Procedure for Reviewing Cases of Plagiarism in Graduation Papers of Students at the Faculty of Computer Science and Information Technology of RTU"), ensuring objective review of the violations. Since 2021, electronic plagiarism control has also been introduced for all student papers. An electronic system developed at the Institute of Applied Computer Systems is used for this purpose.

As the program is implemented in full-time on-site mode, in order to ensure that at least 40% of the workload is completed in contact hours, the semester planning has been changed from a 4-week examination period to a single 20-week semester plan for mastering the study course curriculum and examinations in the autumn and spring semesters.

Currently, in accordance with the Cabinet of Ministers Regulation No 111 (of 8 February 2022) "Procedure for the Organization and Implementation of Remote Studies", smaller groups of students are offered to organize part of their classes remotely in order to simplify the participation of working students in classes. The proportion of remote studies is below 50%.

The other main parameters of the program – languages of implementation (Latvian, English), type of implementation (full-time intramural) and the awarded degree remained unchanged during the evaluation period.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The volume of the study program – 80 CP and duration of studies – 2 years, is designed in accordance with the Cabinet Regulation No. 240 of 13 May 2014 "Regulations on the State Standard of Academic Education". The study program has been developed in accordance with RTU Strategy and the study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science". The curriculum of the study program covers computer science and partly also information technology and computer control.

The aim of the study program is to educate and train specialists with the ability to think systemically, analyze, develop, implement new engineering solutions in computer science and software engineering, develop students' ability to conduct scientific research, participate in local and international projects and continue their studies at PhD level, as well as participate in software development projects in the industry, fulfilling various roles and adhering to IT industry standards and professional ethics.

The study program provides students with advanced academic and practical knowledge in computer systems development, systems analysis, systems modelling and design, database technologies and artificial intelligence.

The classification code of the study program Computer Systems is 45526 - Engineering Sciences and Technologies (other Engineering Sciences), it was chosen because the aim and curriculum of the program are related to the development of computer systems, which is the creation of engineering solutions to solve specific problems of societal importance, which by their nature fall in the scope of engineering sciences. The degree is therefore a Master Degree of Engineering Science in Computer Systems.

The aim of the study programme is achieved by performing all the study programme's tasks. The tasks of the study program envisage the provision of deeper knowledge, the development of special professional and communication skills and abilities necessary to achieve the goal in study courses, as well as conducting independent research within the framework of a Master's thesis. The study results are developed according to the tasks and verified in study courses theoretically and practically, and during the defense of the Master's thesis.

The admission process is regulated by the “Rules for Admission for Post-Graduate Academic and Professional Study Programs” approved by the RTU Senate in its Decision No 655 of 25 October 2021. The prior education requirements have been changed, and applicants with Bachelor Degree of Engineering Science in Computer Control and Computer Science, Computer Systems, Information Technology, Intelligent Robotic Systems, Electrical Engineering, or Bachelor Degree of Natural Science in Computer Science, Mathematics, Physics or an equivalent higher education qualification can enroll. In addition, it is required that the student has completed study courses in the following study fields: Programming (2 CP), Databases (2 CP), Mathematics (3 CP), Fundamentals of Systems Analysis and/or Artificial Intelligence (2 CP). If the candidate has not completed study courses in the respective study field at least in the specified volume, they must be completed in addition to the study program before entry to the program or during the first semester of studies.

The duration of the study programme (2 years) is sufficient so that applicants can acquire the deeper theoretical and practical knowledge, skills and abilities expected as the results of the study programme to the full extent in accordance with the legislative requirements of the Republic of Latvia.

The study programme is implemented in two languages – Latvian and English. The use of the English language allows increasing the number of students thanks to foreign applicants, attracting participants of international students exchange programs and improving the indicators of the implementation of the study programme.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 stipulates that ICT advances and their widespread availability are a catalyst for change in the economy, public administration and society as a whole. The knowledge society, through the targeted application of ICT solutions, transforms existing and creates new processes, business models, habits and culture in all spheres of the economy and life. Digital transformation is the key to productivity, economic growth, individual and societal well-being. At the same time, the number of ICT professionals in Latvia, according to the European Commission's Digital Economy and Society Index, was only 2.2% of the workforce in 2018, well below the European Union (EU) average of 3.7%. The study "Future Goals, Current Directions. Latvia 2022" conducted by the think tank Certus in 2017, revealed that IT sector in Latvia needs up to 3,000 new graduates per year.

According to the Latvian statistics portal, the share of companies employing ICT/IT specialists has increased by 5% in the last 7 years and has reached 73% in 2020. According to the study "Competitiveness of Regions. Latvia Competitiveness Report 2019" conducted by Certus in 2019, the salaries of ICT professionals in leading EU countries are about 30% above the national average, in Latvia the gap is 80%.

According to RTU alumni monitoring data, the employment rate among RTU graduates with a degree in the natural sciences, mathematics and IT is 91%. According to 2017 and 2018 data, natural sciences, mathematics and IT graduates have seen the fastest increase in income in their second year after graduation - 27%, while the average increase in income for university graduates is 20%. Graduates of the master study program "Computer Systems" are in demand in the companies in the sector. For some graduates, the master degree helps them promote their career opportunities in various roles in ICT companies.

According to the Ministry of Education and Science data on 2017 and 2018 graduates, on average 93% of graduates are employed one year after graduation, 96% of them in higher qualification professions according to the Ministry's classification. The average income one year after graduation is above EUR 26,000 per year and two years after graduation – above EUR 28,000 per year. The number of unemployed one to two years after graduation is below 1%. The share of graduate emigration is also low, below 1%.

It is very easy for graduates of the study program to get involved in the labour market, which is proven by a large number of available vacancies in Latvia and abroad. In cv.lv (one of the largest job advertisement portals in Latvia), 840 vacancies in the IT field have been published in August of 2022. Positions of different levels in various IT subsectors are offered by Latvian companies and Latvian branches of international companies, such as Accenture (40 vacancies), ATEA (30), EIS group (17). From the offered vacancies, graduates of the study program can apply for various senior specialist vacancies (~550 vacancies), such as senior programmer, development team leader, system analyst, project manager, data scientist. A very large number of vacancies are also available abroad, for example, LinkedIn offers 10,000 mid- and senior-level software developer vacancies in the UK and 5,000 in Germany, and together these countries offer more than 20,000 senior system analyst vacancies, as well as 20,000 data scientist vacancies.

The study program enhances the knowledge and skills of students – young professionals – in their capacity of programmers, testers, system analysts, data analysts and other jobs. When assessing the employment of graduates by NACE codes, it can be concluded that more than 50% work in the Information and Communication Services sector (J), which corresponds most closely to the profile of the study program. In addition, the second largest number of graduates work in the Financial and Insurance sector (K), which is nowadays heavily based on ICT solutions. In addition, many graduates also work in the IT departments of companies in other sectors. It can therefore be concluded that graduates are mostly working in their field of specialization, working in higher qualification professions already one year after graduation and earning salaries that are well above the national average.

Overall, graduates of the study program "Computer Systems" have expressed a positive view of the program, across all of the more than 200 questions asked in the 2020 survey. On a scale of 5, the availability of necessary information during studies (4.11), the availability of literature (4.3), the provision of classroom aids (4) and the work of academic staff with the e-learning environment (4.51) were highly rated. Students were also generally satisfied with their choice to study at RTU (3.83), their choice to study in the study program “Computer Systems” (3.97). Students are satisfied with the theoretical (3.46) and practical (3.05) knowledge they have acquired, proportion of the theoretical and practical classes (3.54), scheduling of the lectures (3.97) and the premises (3.51) where the lectures were held. It should be noted that since the survey was carried out, the Faculty has moved to new premises where, at the time of writing of this report, due to the pandemic, students had not yet been able to fully experience the learning process. Students were also satisfied with their choice to study at this study program (3.97), including the theoretical (3.46) and practical (3.05) knowledge they have acquired.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The academic master study program “Computer Systems” was implemented in Latvian and English in full-time form during the reporting period. In the reporting period, the total number of students studying in the study program fluctuated from 85 to 155. The number of students who studied in Latvian fluctuated from 51 to 77 students, and the number of foreign students from 19 to 87. The number of students enrolled in the study program varies from 52 to 106 each year. The majority of Latvian students have the opportunity to study in state budget funded seats. The proportion of international students is steadily increasing, except for the last two years, which may be due to the COVID-19 pandemic.

During the reporting period, it has not been possible to establish positive dynamics in the number of students due to the early employment of students in IT companies. Most students have already managed to enter the labor market during their undergraduate studies. According to CV.lv data, well-paid professional vacancies without a Master degree are widely available in IT. Consequently, graduates with a Bachelor degree are focusing on developing their professional careers rather than continuing their studies.

Similar to the number of students, the number of graduates varies between 8 and 22 (from 4 to 12 studied in Latvian, but from 3 to 13 studied in English) due to various external factors, including the COVID-19 pandemic in the last two years, which made it difficult for students working and studying remotely to complete their graduation paper in due time.

The proportion of international students has increased significantly over the reporting period (from 19 students, or 22% of the total number of students in 2013, to 41 students, or 44% of the total number of students in 2021). All international students are full-time tuition fee paying students. When analyzing the country of residence of the students, it can be concluded that the number of Indian students has also grown the fastest, from 11 students in 2013 to 55 students in 2021, and represents the largest share of international students in the study program. Among the other countries, Uzbekistan, Pakistan, Sri Lanka and Azerbaijan have the largest numbers of representatives. The average number of mobility students in this study program is 19 students per year.

The increase in the number of mobility students is due to both the reputation of the program among international students and the cooperation with several foreign educational institutions that recommend their students to spend part of their study time at RTU. Examples of such institutions are EPITA, School of Engineering and Computer Science, and IPSA, Institute of Polytechnic Science and Aeronautics in France.

The increase in the number of international is due to both the reputation of the program and the expanded student attraction activities, for which the resources of RTU International Cooperation and Foreign Students Department (ICFSD) are being used. The ICFSD uses several types of information channels, choosing the most appropriate for each target audience: paid or advertising channels, public relations channels and its own channels. Marketing communication is an essential part of reaching out to foreign audiences, using all the classic marketing tools – advertising in the media and other channels, event marketing, direct marketing, digital marketing, etc. The main marketing tools used to reach foreign audiences are participation in various educational fairs and seminars organized by educational agencies in defined target markets. Since 2015, an average of 80 educational fairs and/or seminars organized by cooperation partners have been attended annually to promote study opportunities at RTU. During the pandemic period in 2020 and 2021, on-site exhibitions and seminars were replaced by virtual exhibitions and seminars, and in addition, "RTU Virtual Open Days" were organized every month, where foreign students studying at RTU FCSIT also shared their study experience. The continuity of information provision and promotion of studies abroad is ensured by long-standing cooperation partners in partner universities and educational agencies. To ensure that representatives of educational agencies and partners provide students with up-to-date and relevant information about studies, RTU organizes an annual online training for partners; in 2019, such training was organized on-site, where partners had the opportunity to learn about RTU infrastructure, study opportunities, etc.

To ensure permanent presence of RTU in specific countries, thereby increasing RTU visibility and attracting more outstanding students, RTU opened RTU Information and Study Centre in Colombo (Sri Lanka) in 2016, followed by Chennai (India) and Tashkent (Uzbekistan) in 2019, and Ankara (Turkey) in 2020. RTU Information and Study Centers abroad have allowed RTU to monitor the level of knowledge and compliance with RTU requirements of admitted foreign students before their arrival in Latvia, as well as to reconcile the different Latvian and foreign secondary education systems.

In recent years, the number of dropped out students has been proportional to the number of students in the study program. The majority of students are withdrawn for academic failure, which occurs when a student fails to complete the study course requirements for various reasons. This tendency is independent of the implementation language. The number of students withdrawn for academic failure in each academic year varies between 13 and 46. The highest dropout rates are observed in the first year of studies, which are mostly due to academic failure. A total of 221 students or 22% (see Annex 5 Statistical data on the students at the academic master study program "Computer Systems") of the total number of students were withdrawn for failure during the reporting period. Most students mention large workload that they have to deal with combining full-time job with full-time studies as a reason why they could not meet the requirements of the study program. The second most frequent reason for dropping out among local students (and the third most frequent reason among foreign students) is voluntary, and 4-11 students drop out for this reason each year. The most frequent explanation is the inability to combine studies with work commitments or other activities. But the second most frequent reason for dropping out among foreign students is not starting studies after matriculation (up to 8 students per year). No other clear trends have been identified; the reasons for extending studies or dropping out vary from year to year. It should be noted that in this specialization, students are often employed on full-time basis in the industry and are often away on long business trips. Other common reasons for dropping out are dropping out as a non-starter after academic leave (2-10 students per year), not starting studies after matriculation (2-12 students per year) or not attending classes (1-12 students per year). In two last years, 20 students were exmatriculated for not fulfilling the agreement with RTU, which can be explained by the economic situation during the pandemic. Less than 2 students per year are withdrawn for other reasons.

When assessing the dynamics of students studying on state budget and tuition fee paying students, it can be concluded that, on average 97% of the total number of available state budget funded seats are filled each year. The number of state budget funded seats is dynamic each year and is based on the current number of students and the forecast demand for the study program. Based on the most recent available data, the number of state budget funded seats available corresponds to the number of applicants for the master study program.

On the other hand, the proportion of tuition fee paying students, which is mainly based on international students, has increased significantly and during the period from 2013, when the proportion was 18%, has increased to 44% of the total number of students.

Charts with statistical data on the number of students in the study program Computer Systems are available in Annex P05 “Statistics on the Students of the Academic Master Study Program Computer Systems”.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

Study program curriculum complies with Cabinet Regulations No 240 of 13 May 2014 “*Regulations on the State Academic Education Standard*”. The compliance is described in Annex P06 “Compliance of the Academic Master Study Program “Computer Systems” with the State Education Standard”. The study courses included in the study program were developed in compliance with the valid normative acts: Cabinet Regulations No 322 of 13 June 2017 on the Classification of Latvian Education, the Law on Institutions of Higher Education (current version), RTU Study Regulations, Regulations of the Study Course Register and 27 May 2017 RTU Senate Decision on Evaluation of

Learning Outcomes.

Study course descriptions are regularly updated in line with the needs of the industry, the labor market and trends in the field of computer science and information technology. Considering the rapid changes in the IT industry and technological developments, study courses are regularly updated and study program curriculum is modified, thus ensuring that the study program meets the needs of the labor market and the trends in the IT field. Some examples of changes:

- Due to the wide application of agile methods and process automation in software development, the program has been supplemented with the study course "Testing and Software Quality".
- Given that the volume and complexity of data processed today continues to grow rapidly, the study course "Special Data Processing Technologies" has been modified to focus on information retrieval and search technologies.
- In order to better train students to work in a project-oriented environment in the IT industry, the study courses have broadened the range of group projects, requiring students to work in teams to solve complex problems related to software development.
- In view of the fact that machine learning has become the dominant approach in the last 10 years, study courses in artificial intelligence have been added to both the compulsory and free elective parts of the program.
- With the development of new data storage and retrieval technologies, the study course on database technologies has been updated to include the latest industry trends in terms of both technology and logical models.
- In order to enhance student' ability to put into practice and apply the theoretical concepts of computer science mastered, the number of practical study projects for students has been increased in various study courses.

The compulsory part of the study program includes study courses in the amount of 36 CP, which offer in-depth knowledge of the field of computer science in general and its formal foundations, develop the ability to choose appropriate methods for solving a problem, the ability to implement algorithms appropriate to the problem, use software development environments and tools.

As described in 3.2.6 "Analysis and assessment of the topics of the final theses", the academic and scientific staff of the Institute of Applied Computer Systems (IACS) follow the latest trends in IT research and propose the topics for the final theses corresponding to them, accordingly involving Master students in the research conducted by the faculty.

Field-specific study courses complement the technical knowledge base acquired during the Bachelor studies for practical software engineering problem solving and decision making in today's changing environment. Within the field-specific study courses, students can choose one of the three majors of the study program - Computer Systems Design, Applied Computer Science and Software for Applied Computer Systems. Students choosing the Computer Systems Design major acquire in-depth knowledge related to knowledge management, systems analysis and design. In the Applied Computer Science specialization, students gain a deep understanding of object-oriented systems development, modern applied computer science methods and the quality of software development organization. The major in Software for Applied Computer Systems focuses on specialized software development methods, software security and intelligent methods for building computer systems.

The study courses in humanities included in the compulsory elective part of the study program and the group work included in the other study courses develop the social competences necessary for an IT professional, the ability to continue education and development, critical and creative thinking. Free elective study courses allow students to choose study courses according to their professional interests and needs. All majors include relevant seminar-style courses that teach students how to conduct research and analyze the results of other authors.

Consequently, the aims, objectives and learning outcomes of all parts of the study program lead to the achievement of the learning outcomes and the overall aim of the study program, as well as the fulfilment of the tasks. Regular analysis and updating of study courses eliminate overlaps and duplication. The mapping of the learning outcomes of the study courses against the program learning outcomes is given in Annex P08 “Mapping of study courses for the study program “Computer Systems””. The mapping indicates that the learning outcomes contributing most to the first program outcome “able to independently define and critically analyze scientific and professional problems”, which is related to the student’s ability to independently think critically. The achievement of each study program objective is ensured by the attainment of at least 20 learning outcomes of the study courses, which is fully sufficient. The lowest number of links between the study course learning outcomes is with the student’s ability to perform innovations in software engineering industry. This is due to the fact that the ability to innovate is based on all other program objectives - the student’s ability to innovate depends on the ability to use complex environments and tools, to evaluate and select software products, tools and methods adequate to the program, to adapt professionally and learn new methods and technologies, to put into practice and apply theoretical concepts of computer science. All of these objectives are supported by at least 30 study course learning outcomes.

The mapping also indicates that the program’s objective to train students to work in software development teams and be able to carry out research and present the results is supported by at least 45 study course learning outcomes. Working in groups also promotes innovative thinking and thus the fulfilment of objective of being able to innovate in the software engineering field.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The master study program “Computer Systems” provides higher academic education rooted in fundamental and applied research in computer science and information technology. The Master degree enables students to work as a researcher and to pursue PhD degree. Students are provided with in-depth acquisition and integration of academic, practical and professional knowledge, ensuring that the graduate is able to put into practice and apply theoretical concepts of computer science to solve complex problems.

The aim of the study program is to educate and train the specialists with advanced knowledge of computer science, software engineering and computer systems development theory, as well as programming languages and software development environments, who are familiar with the latest technologies in artificial intelligence and databases, and who are able to participate in a software development project by performing various (including managerial) duties and adhering to IT industry standards and professional ethics. To train students so that graduates of the program can work at the university, work as specialists in companies of the IT sector, including research work in computer companies and organizations, and continue their studies at the PhD level.

The study program ensures that the curriculum of the study courses is up-to-date and relevant to the needs of the labor market in the field of software development and the latest achievements and knowledge in the field of computer science and information technology.

Upon completion of the master studies, the student is required to develop and present a Master Thesis in the volume of 20 CP. The Master Thesis is an independent research work, which is developed in close cooperation with the academic staff and researchers of the Institute of Applied Computer Systems, considering the needs and current problems of the industry, as well as current research directions in computer science and information technology. The Master Thesis and its presentation demonstrate the student’s ability to analyze, classify, compare ideas presented in scientific research and technical literature in the field of computer science and information technology, to acquire, collect, analyze and evaluate data, applying methods, methodologies, technologies, computer systems and development tools and languages to solve problems, to formulate problems, integrate the acquired knowledge and make assumptions about possible innovative solutions to these problems. As a result of the Master Thesis, students propose a scientific innovation in the field of computer science and information technology. The Master Thesis must be designed in such a way that its results can be published. The award of the degree is based on the public presentation of a reviewed theoretical and/or practical study - the Master Thesis - and the results of the study course examinations.

Master Theses are related to the current issues in the field of computer science and information technology, for example, the following theses were awarded the grade “with distinction”:

- research on modelling languages and tools – “Comparative Analysis of the UML Modeling Tools”, “Analysis of Two-Hemisphere Model Usage for Generation of UML Diagrams”, “Development of UML Class Diagram Layout Algorithm”, “Two-Dimensional UML Class Diagram Processing, Using Principles of Knowledge-Based Architecture”, “Comparison of Model Driven Software Support Tools in the Context of Model Data Exchange”, “The Research on Backward Derivation of the Topological Functioning Model from Source Code”, “Comparative Analysis of Methods for Transformation of CIM Based on Topological Functioning Model and BPMN to PIM in the Context of MDA”, “Research on Usage of Object-Oriented System Analysis Methods for Software Requirement Determination”,
- software development technologies – “Research on XML Technologies of Semantic World Wide Web”, “Research on Test Automation of Cash Systems, Cash Registers, and Specialized Devices”,
- information security – “Comparative Analysis of Digital Steganography Methods”, database technologies – “Evaluation of NoSQL and NewSQL - the Improved Variants of Relational Databases”,
- artificial intelligence – “Multi-agent System Development for Identification of Politically Exposed Persons”, “Application of Computational Intelligence Paradigms in the Development of Intelligent Agent Control Mechanism”, “Sentiment Analysis in Latvian Tweets”.

The topics of the Master Thesis are described in more detail in Section 3.2.6.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

Implementing the study process, the responsible instructor of the study course determines the assessment criteria and methods for the acquisition of the study course. The student is informed about the assessment procedure for each study course in the e-environment at the beginning of studies. When planning the study process, the responsible instructor determines the pedagogical methods for mastering each topic to be addressed within the study course.

The study process is implemented in the following modes: lectures, practical classes, laboratory and independent work implemented individually and in groups, tests and graduation paper.

The aim of lectures is to ensure acquisition of the theoretical material of the study course. Hybrid teaching methods are used to achieve the learning outcomes, combining verbal teaching methods, explanatory teaching methods, interactive teaching methods and demonstrative teaching methods. Various forms of feedback are actively used during lectures, including modern IT solutions such as student survey tools (e.g., https://www.mentimeter.com/, https://kahoot.it/, https://quizizz.com/), which also assist in implementing of emotional stimulation and appreciation methods.

The materials used during the lectures are uploaded to the e-learning environment and are available to students throughout the entire period of implementation of the study course. During the lectures, the academic staff facilitate discussions which help update the topics covered during the lectures and motivate students to search/discuss possible solutions to the problems.

The aim of the laboratory work is to develop practical skills in the topics of the study courses using the laboratory equipment. In laboratory work, the academic staff combine a variety of practical teaching methods, including instructional and productive methods, as well as methods of teaching skills and methods for the use and strengthening of creativity, to achieve the objectives.

The aim of independent and practical work is to strengthen the theoretical knowledge acquired at the lectures by applying it to the analysis and solution of various tasks, situations and problems. To achieve the objectives, the academic staff use similar methods to those used in laboratory work, supplemented by problem-oriented methods and learning discussions, but without the use of laboratory equipment. Independent study plays an important role. Independent work is included as a compulsory component in several study course descriptions.

Practical, independent and laboratory work is organized both individually and in groups, ensuring that students develop both their individual skills and the skills essential in the IT industry to work in teams, as well as to formulate and delegate tasks, and to present their results. Group work is organized within the following study courses: “Object-Oriented System Analysis”, “Testing and Software Quality”, “Large Databases”, “Software Quality”, “Requirements Engineering”, “Theory of Software Reliability”, and “Workshop on Applied Computer Science”.

The purpose of tests is to assess how students have acquired the theoretical knowledge and developed the relevant skills. Depending on the knowledge and skills to be tested, the following forms of assessment are used: assessment tests, test work, examinations and credit tests.

For graduation papers the research method is mainly used, as well as the practical teaching method, the heuristic (discovery) teaching method and the skill-building teaching method. To develop discussion and presentation skills, as well as to discuss and promote the results of the graduation paper, students are offered the opportunity to participate in RTU Student Scientific and Technical Conference.

Students acquire practical and research skills by regularly using literature and internet resources, including international scientific databases available in RTU Library with electronic access in ORTUS environment, in order to successfully develop their research papers.

Organizational units of RTU, including HR, research, international relations, academic units, as well as the Centre for Academic Excellence, regularly inform staff about the opportunities to improve their competences in the areas of scientific research, methodological and didactic skills, general competences and specific professional activities. ORTUS environment provides information on the scientific activities of academic staff. In order to carry out pedagogical work at a high level, methodological seminars are organized for RTU academic staff on the possibilities of using various teaching methods, share experience and good practice.

The academic staff of the program regularly improves the study curriculum by introducing new, innovative study organization and teaching methods in the study process, the main aim of which is to teach how to learn, find information, use different sources of information, argue, collaborate with others, make decisions and take responsibility. Cooperation here is both student-student and teacher-student oriented. International experience is integrated into the study process.

In the academic matters, individual approach is ensured in accordance with the RTU Academic Staff Work Planning Guidelines, which stipulate that academic staff should provide consultations for every 25 students in a lecture stream at the rate of 15% of the lecture amount. Students can receive individual tutorials from the academic staff according to the schedule approved by the head of the department, which is available in the e-learning environment.

In addition, individual consultations are provided for the supervision of coursework and projects, internships and Master Theses. Pre-examination counselling is organized before examinations. If necessary, students can directly contact academic staff outside the tutorial hours by sending their questions in the form of messages or in the appropriate course forum in ORTUS system or by e-mail.

RTU e-learning environment ORTUS based on Moodle platform is actively used to support the study process, which contains study materials, knowledge self-assessment tools, task submission functions, testing functions, as well as video recordings of lectures that are used during the remote studies. The use of the e-learning environment is mandatory for RTU academic staff. The plagiarism detection software developed by IACS is used for the submitted papers. All resources available in the e-learning environment can be used by the student at their own pace and according to their individual needs.

The appropriately chosen teaching methods allow implementing the study program in two languages - Latvian and English. The study program in the Latvian language is mastered by local students, while the study program in the English language is mastered by foreign students. To ensure the quality of studies, academic staff with the English language competence at the level at least B2 are involved in the work with foreign students.

RTU considers all aspects of student-centered education in order to increase students’ motivation and improve the quality of their studies.

1. Student involvement in the study process and content development

In accordance with the procedures developed by RTU, students have opportunities to provide regular feedback on the study content. Students are regularly involved in the quality assessment of study programs and participate in the work of decision-making and advisory bodies. In addition to the formal processes, there are regular meetings between students and the head of study program to discuss the content and quality of the studies. There is a semesterly survey in which students give feedback on the study course as a whole. Students also have the opportunity to contact the head of study program or RTU Study Department at any time, where there is a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to software development and other IT processes, and link the outcomes to the study program learning outcomes and the study course volume in terms of credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (document, presentation, video recording, interactive learning materials, etc.). Students can propose their own theme for the graduation paper, thus achieving the learning outcomes in a way that interests them.

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. RTU also regularly uses the opportunity to invite guest lecturers to share their experience with students in the form of individual guest lectures or complete study courses. By meeting guest lecturers in specially organized seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad. Further information on guest lecturers and academic staff mobility is given in section 3.4.1 “Assessment of the compliance of the qualification of the teaching staff members”.

4. Social dimension

Students studying in the study programme “Computer Systems” have sufficient flexibility to combine work/family life with their studies. As a positive fact it should be noted that RTU library is available to students 24 hours a day and also at weekends.

5. Teaching and learning methods

The teaching and learning methods described previously are used in the implementation of the study program and are adapted by the academic staff to the specific situation. Students have the opportunity to receive individual tutorials from the academic staff involved in the study program, including communication in the e-environment using RTU licences for Zoom and MS Teams platforms, as well as messaging services of the Moodle platform.

6. Learning environment

In 2021, a new FCSIT faculty building was opened on Zunda krastmala 10. Students have access to all the technical equipment needed for modern IT education - computer labs, including virtual computer labs. The new building has quiet working and relaxation areas on each floor. Modern videoconferencing tools such as Zoom and MS Teams licenses for remote lectures and tutorials, as well as other software licenses, including academic ones (e.g., MS Office, and various software development environments and tools) are also available. Classrooms also have the technical equipment to support hybrid learning, thus enabling foreign teachers to be involved in teaching a part of a course/lecture from a distance.

Throughout the implementation of the study program collaboration between librarians and academic staff is ensured, with the aim of improving teaching and learning process. In the first year of studies, students are introduced to the resources and databases available in the library.

Following the modern demand, RTU Scientific Library is digitalizing, offering more and more resources in e-format, including the most important databases of scientific articles in the IT field (IEEE, SpringerLink, ACM, ScienceDirect, Wiley, etc.).

7. Academic staff competence development

The academic staff involved in the study program are provided with regular opportunities to develop their methodological and didactical skills. The competence development process of academic staff includes methodological seminars of the Institute of Applied Computer Systems and the Faculty on the use of teaching and learning methods, including innovative teaching methods, as well as RTU Methodological Conference. The following methodological seminars have been held in recent years:

- 20.02.2019. Academic Integrity and Work with International Students;
- 18.12.2020. Organisation of Remote Examinations;
- 12.02.2021. Implementation of Distance Learning;
- 12.03.2021. The Digital Age Student (Zanda Rubene, Professor, University of Latvia);
- 28.01.2022. Academic Integrity at RTU and FCSIT;
- 25.02.2022. Formative Assessment: with and without technology (Anžela Jurāne-Brēmane, Researcher, Vidzeme University of Applied Sciences).

SAM 8.2.2 project provided the opportunity to do internships in IT companies, thus mastering the latest approaches and methods used in the industry in order to integrate them into study courses.

8. Extra-curricular activities for students

A wide range of extra-curricular activities are offered to the students of the study program:

- Students are also involved in scientific work and research on the topics relevant in the field, participating in both local and international projects, which gives them the opportunity to participate in international conferences. As part of the Master Thesis development process, the student most often joins one of the Institute's research fields.
- Each year, a Student Scientific and Technical Conference is organized, where students have the opportunity to gain first-hand experience in publishing their research results.
- Every student at RTU is offered opportunities to participate in extra-curricular activities (sports teams, dance groups, choirs, etc.) organized by different RTU departments.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

During the reporting period, 59 young professionals graduated from the study program, fully completing the program requirements and elaborating a graduation paper, thus demonstrating their ability to carry out research in the field of computer science and information technology.

The academic Master study program "Computer Systems" offers students to select thesis topics both related to the traditional and fundamental approaches to software development, as well as the topics related to the application and research of modern technologies and methods (including artificial intelligence). The Institute of Applied Computer Systems maintains productive collaborations with the companies in the industry, thus some students elaborate graduation papers on topics defined by the companies and relevant to the industry at the time. By elaborating a Master Thesis in one of the areas listed below, the student becomes an expert in an area of relevance to the IT industry, and is getting ready for the PhD studies in the respective research field.

Artificial intelligence

Includes: machine learning, including deep neural networks, intelligent agent technologies, distributed intelligent systems, knowledge engineering, ontologies, intelligent robot and multi-robot systems, various tasks in robotics (interaction, self-localization, navigation, mapping, task allocation), various applications of AI techniques, computer vision, natural language processing, and affective computing.

Data storage, search and processing technologies

Includes: latest database technologies, big data storage and processing, data analysis and visualization, data analysis and visualization, data analytics and business intelligence methods, information retrieval technologies, web crawlers and search engines.

Systems theory, systems analysis, design, modelling and systems engineering

Includes: systems theory models and applications, systems analysis and design, continuous systems engineering, modelling of system structure and performance, topological functioning model, use and development of modelling languages, use and development of modelling tools.

E-learning systems

Includes: intelligent learning systems, artificial intelligence and software solutions for learning purposes.

Information systems security

Includes: information security and computer systems security, security methods and tools, reverse code engineering, reliability of operating systems, blockchain technologies, payment systems.

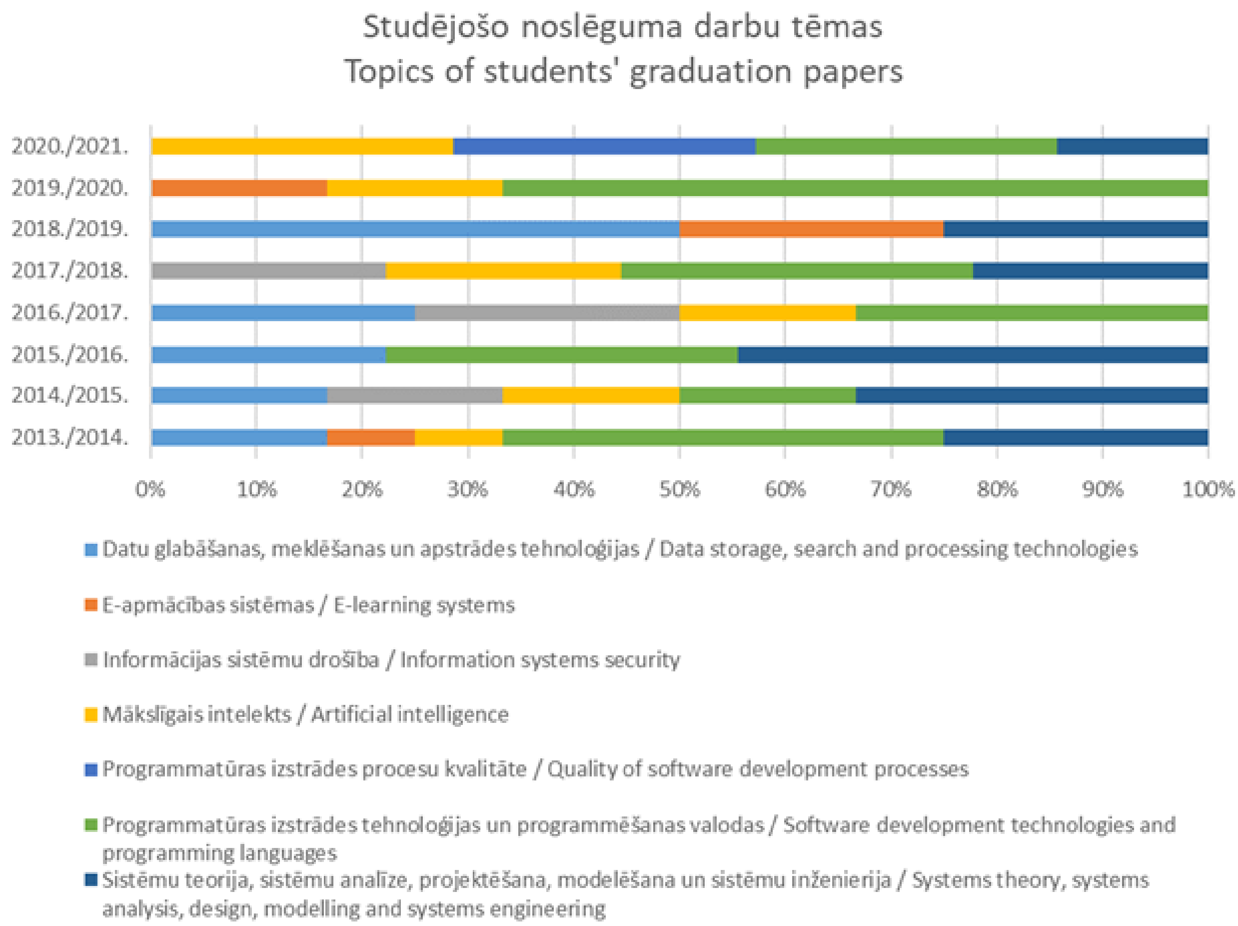
Software development technologies and programming languages

Includes: software development technologies and languages, object-oriented languages and methods, functional languages and programming, aspect-oriented languages and programming, software testing and test automation tools, DevOps, continuous integration and delivery, cloud computing, microservices architecture, model-driven software development technologies and tools, distributed systems development, Internet of Things systems.

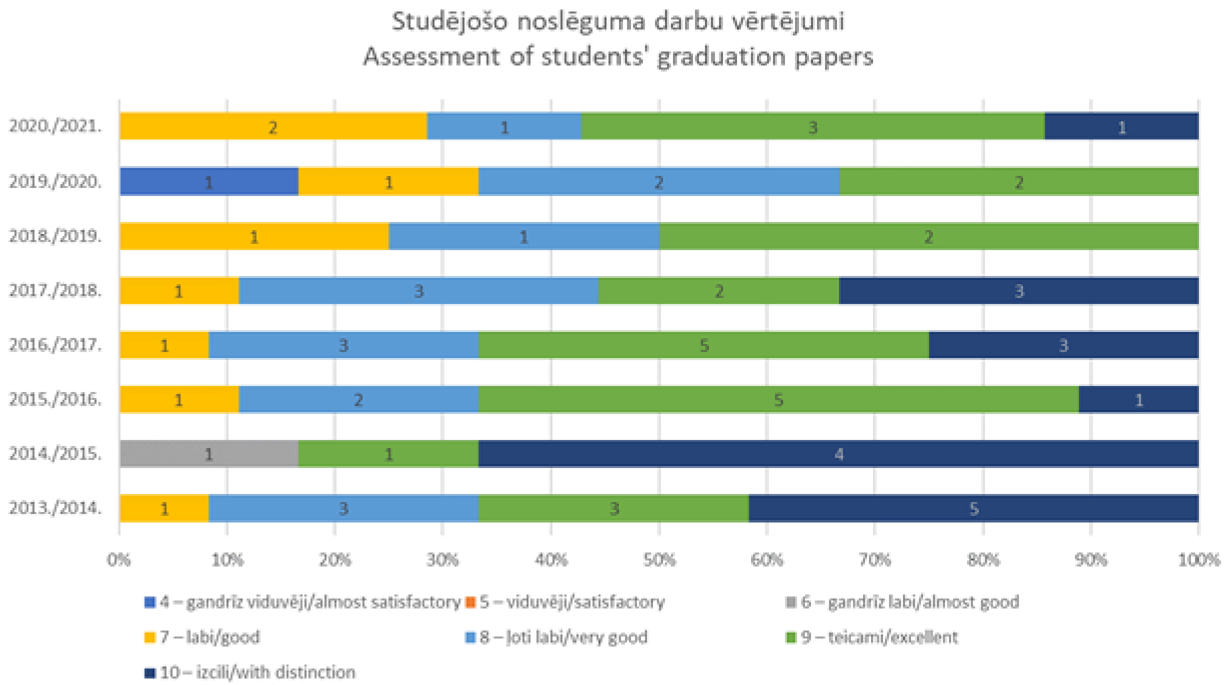
Quality of software development processes

Includes: traditional and advanced models of the software development life cycle, quality management models.

The overall distribution of graduation papers by topic for each academic year is shown in the figure below. As can be seen, most graduation papers are written on topics that directly correspond to software development technologies and programming languages. This is due to the fact that these topics are very closely related to current developments in the Latvian IT industry, as well as they correspond most directly to the development of computer systems, which is the technological focus of the program. However, a significant number of Master Theses are also written on conceptually new technologies and models that are relevant today, as well as on other components of a software development project. The second most popular group of topics is related to systems analysis, design and modelling. On the other hand, topics on various sub-topics of artificial intelligence and topics on modern data storage and processing technologies are the next two largest groups of topics. The total list of topics by year and the grades obtained by students are given in Annex 3.2.6. "Topics of students' graduation papers".



The distribution of students' grades in each year of study is shown in the figure below. As can be seen, the Master Theses are mostly evaluated with high grades - only in some cases students obtain grades 4-6. To earn a grade "with distinction" (10), it is necessary to validate the results of the work by producing a scientific publication. As shown in the figure below, there have been 17 such Master Theses in the reporting period.



3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The following resources are used for the implementation of the study program:

- Auditoriums for lectures and practical classes. The study program is implemented at the Ķīpsala Campus, which has both FCSIT rooms and RTU joint use premises. The facilities are accessible for persons with disabilities. Available classrooms are described in Part II, Chapter 3, Section 2.3.2 - Resources and Provision of the Study Field.
- RTU information platform ORTUS and E-learning environment, which provide support function for information exchange between the faculty and students, the study process, available study course materials, posted and completed tasks, assessment tests, etc.
- Computer classes and computer labs, which are of particular importance given the specific nature of the program. The necessary software is purchased and installed in the computer labs appropriate for each study course, mostly academic licenses are used for specific software. 5 joint use computer classrooms (140 computers in total) are available at FCSIT and 5 specialized computer labs (150 computers in total) are available at the Institute of Applied Computer Systems. Windows, Linux, MAC and mobile computer classes are available. Computer labs provide students of the study program “Computer Systems” with equipment necessary for the development of group projects, laboratory works and research during their

studies.

- FCSIT joint use computing centre, which provides access to computing resources in the cloud. Virtual computer labs are also available for students to use specific software remotely. Licensed Microsoft office software and software development tools are also available to students for learning purposes.
- Virtualisation services that allow students to obtain the computing resources they need for various tasks and experiments with the appropriate software and infrastructure, including a fixed internet connection.
- In 2015 FCSIT opened National Research Centre of Information, Communication and Signal Processing Technologies, where students have the opportunity to join programme-relevant research in fundamental and applied research in computer systems development, in particular but not limited to the development of their Master Thesis.
- RTU HPC provides necessary computing power for resource demanding student research, for example, training deep neural networks.
- RTU Scientific Library.

The computer class equipment used in the study programme provides the full performance of laboratory and practical work using the current technical provision. A wide range of operating systems and technical solutions (Microsoft, Linux, Apple products) provides option to observe the operating and processing principles of software in different environments.

Mobile class (Android based devices) gives option to use digital materials and knowledge testing tasks during lecture time (interactive interaction tools that require predesigned configuration and increase the level of reliability of the identity of the task or knowledge test accomplished in the learning process).

IACS virtualization solutions provide option to integrate students' computers into the learning process, using a cloud-based solution available to students with a predesigned configuration that reduces the time for preparing the computer for performing a task.

In the study year 2018/2019, the computer classes and laboratory premises of the Institute of Applied Computer Systems for training and scientific research were occupied for 90% of available time.

RTU Scientific Library stocks a wide range of books and other resources appropriate for the academic Master study program “Computer Systems” (description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3.). The search for resources in RTU Scientific Library is provided by a united resource search tool. Upon request of administration of the study program “Computer Systems”, 295 new books have been purchased in the period 2013-2021 for the amount of EUR 16024.64.

Part II, Chapter 3, Section 2.3.3 lists the e-resource collections available in RTU Scientific Library. The content of the following collections is most relevant to the specific nature of the study program Computer Systems: ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, EBSCOhost Web, ScienceDirect Freedom Collection, SCOPUS (Elsevier), Web of Science (Clarivate), learning materials repository Merlot, Latvian Standards Database (available only in the library premises). There is also an interlibrary loan and resource sharing system, ExLibris, where students can order books and journals that are available in other libraries.

Wireless Internet connection is available to students in all RTU premises, which enables students to study additional materials, participate in various interactive activities during the lectures, such as polls. The Institute of Applied Computer Systems also has the necessary equipment and software licenses for remote work with students, as well as the possibility to provide hybrid work, where some students are in the lecture room and some connect to the lecture remotely. Before the Covid-19 pandemic, students could exchange books or use specialized books and journals bought within the ERDF projects.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and facilities meet the conditions for the implementation of the study program and contribute to the achievement of the learning outcomes. The academic Master study program “Computer Systems” is implemented both as a study program with state budget financing, with 33 state budget funded seats, and as a tuition fee funded study program for the international students.

The data on funding are presented in the table below (see Table 3.1).

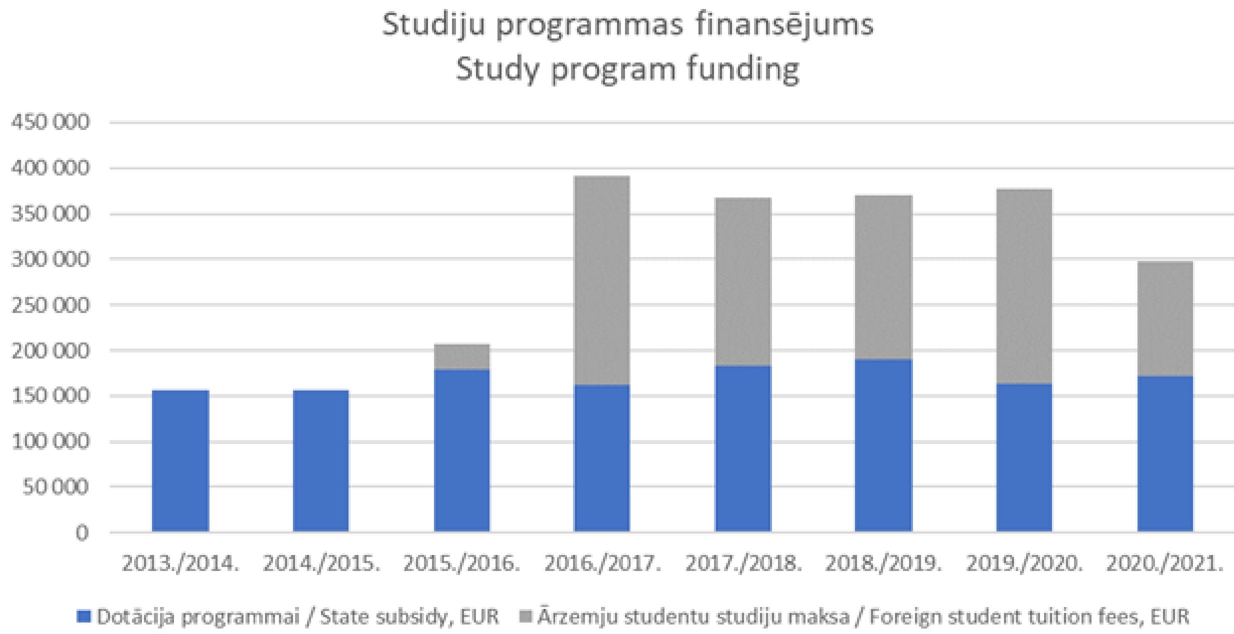
Table 3.1

Study Program Funding

Academic year	State subsidy, EUR	Tuition fees at the program, EUR		Total study program funding, EUR	Funding of one state budget funded seat, EUR
		Local student tuition fees, EUR	Foreign student tuition fees, EUR		
2013/2014	157 172	0	*	157 172	5 799
2014/2015	157 386	0	*	157 386	5 799
2015/2016	179 015	0	27 747	206 763	5 799
2016/2017	162 529	0	228 770	391 299	5 799

2017/2018	182 595	0	185 541	368 136	6 061
2018/2019	190 247	0	180 372	370 619	6 345
2019/2020	163 215	0	213 565	376 780	6 608
2020/2021	171 701	0	125 562	297 263	6 694

* Data on the international students are not available for academic years 2013/2014 and 2014/2015. Considering the data on the number of students, it can be concluded that the figures were slightly lower than in academic year 2015/2016.



As shown in the table and the figure above, the Master study program “Computer Systems” has seen an overall increase in funding over the reporting period, based on tuition fee income from international students from 2015 onwards. Analyzing the growth items, it can be concluded that the state budget subsidy has not increased in recent years, while the tuition fee income has increased.

In the reporting period, it can be observed that tuition fee income represents on average 50% of the total income from 2015 onwards and is already comparable to the state budget subsidy. Currently, the only increase in income is due to the payment of fees by international students, which allows the full implementation of the program in English.

Based on the 2015 “Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation” conducted by the Ministry of Education and Science, as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study program, RTU has determined that the academic Master study program must educate at least 19 students in each academic year. The number of students per study year at the study program is 69 and 38.

Information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the cost per student is given in the Annex “Breakdown of funding between cost items”. Information on the minimum number of students required at the study program is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study program”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study program comply with the conditions for the implementation of the study program and the requirements of the regulatory enactments. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The responsible instructor is appointed by the head of the responsible structural unit. Instructors responsible for study courses can be professors, associate professors and assistant professors with a scientific degree in the relevant branch or sub-branch of science. All responsible instructors involved in the implementation of the study program Computer Systems hold a PhD degree and each is an expert in their research field, which is attested by the scientific publications they published and research projects they implemented. In total, 71% of the academic staff involved in the implementation of the study program hold a PhD degree. In some cases, industry professionals with the necessary practical experience are involved. In total, 28 academic staff members are involved in the implementation of the study program.

Elected academic staff participate in the implementation of the study program, the election of which and the observance of the necessary quality requirements are regulated by the RTU Regulations No. 589 adopted on April 27 2015 “Regulations on the Procedure for Election of Docents, Lecturers and Assistants” and No 649 adopted on April 26 2021 “Regulations on the Procedure for Election of Professors or Associate Professors and Qualification Assessment of Professors and Associate Professors”, as well as the Rector's order on the procedure for evaluating the performance of professors and associate professors (No. 01000-1.1-e / 157 of 7 October 2021).

The number of academic staff involved in the implementation of the study program is 28; the number of guest teaching staff is 15 (total during the reporting period).

Summary on the involvement of the guest lecturers in program implementation:

Name, surname of the guest lecturer	Organization	Date	Study course, activity	Contact hours
Miloš Stojmenovič	Singidunum University, Novi Sad, Serbija	3.02.2020.-31.07.2020	Instructor at the free elective course “Deep Learning Approaches to Computer Vision”	64

Zigmunds Buliņš	Ltd “innoForce”	2014/2015 2015/2016	Free elective study course “Information Systems Security”, lectures and laboratory works	32
Gunārs Blumbahs	Accenture Latvia	01.09.2021.-20.12.2021	Supervised practical tasks within the study course “Software Quality”	32
Gunārs Blumbahs	Accenture Latvia	02.09.2019.-20.12.2019	Supervised practical tasks within the study course “Software Quality”	32
Nisrine El Marzouki	*Sidi Mohamed Ben Abdellah University*, Maroka	10.10.2016.-16.12.2016	Academic assistant at the practical classes within the study coursed “Object-Oriented System Analysis”	16
Andrejs Savčenko, Aleksejs Buzdins	C.T.Co LTD	26.11.2018	Lecture “Configuration Management” within the study course “Software Metrology and Planning Models”	4
Kalvis Kalniņš	Accenture Latvia	25.10.2021	Lecture “Introduction to User Experience and Design Thinking for Business” within the study course “Object-Oriented System Analysis”	4
Arturs Adejanovs	Accenture Latvia	15.11.2016	Lecture “Design patterns, introduction to SOLID” within the free elective study course “Software Development Patterns”	2
Ingrīda Kikuste	Accenture Latvia	08.11.2021	Lecture “Business Requirements Documentation” within the study course “Object-Oriented System Analysis”	2
Ilze Auziņa	UL Institute of Mathematics, Artificial Intelligence Laboratory	31.10.2019	Guest lecture “Artificial Intelligence in Humanities" within the study course "Foundations of Artificial Intelligence"	2
Bozhikov Asen	D.A. Tsenova Academy of Economics	04.04.2017	Guest lecture within the study course “Requirements Engineering”	2
Hazim Kemal Ekenel	Istanbul Technical University, Turkey	29.03.2017	Guest lecture on face image processing and analysis within the study course “Artificial Intelligence”	2

Mirgita Frasheri	Mälardalen University, Sweden	27.11.2018	Guest lecture on adaptive autonomy in multi-agent systems within the study course “Artificial Intelligence”	2
Kaspars Osis	Vidzeme University of Applied Sciences	22.04.2016	Guest lecture within the study course “Knowledge Management” on personal knowledge management	2
Saulius Gudas	Vilnius University, Lithuania	06.05.2016	Guest lecture within the study course “Knowledge Management” on knowledge management systems	2

To ensure and improve the quality of studies, the academic staff involved in the implementation of the study program regularly improve their academic and professional knowledge at methodological seminars, conferences (national and international), as well as in scientific and research work, participate in various scientific and methodological projects. Training and qualification improvement are carried out through participation of academic staff in conferences and seminars, studying in various courses, participation in the work of other organizations, practical work as experts and consultants. RTU provides access to edX and Coursera study courses in the areas of interest to the academic staff. RTU organizes an annual methodological conference, which is regularly attended by the academic staff of the Institute of Applied Computer Systems as listeners and presenters.

A particular highlight is the *Buffalo Program*, launched in 2019, which brings academic staff members to the State University of New York at Buffalo, USA for a semester-long internship. Currently, the following academic staff members of academic Master study program “Computer Systems” have completed the internship process: Professor Marina Uhanova and Associate Professor Alla Anohina-Naumeca.

The compliance of academic staff with the requirements for the implementation of study courses is confirmed by the data included in the CVs of academic staff and their research results (scientific projects, publications, presentations at scientific conferences, as well as contractual work). In accordance with the Law on Higher Education Institutions, academic staff also carry out research activities in the relevant field alongside their academic activities. Academic staff are free to choose their field of research and to propose appropriate topics for graduation papers. Within the 2021 International Evaluation of Scientific Institution Activity, RTU Faculty of Computer Science and Information Technology was awarded a four-point rating.

Brief summaries of the academic staff activities are given below.

Assoc. Prof. Egons Lavendelis

Head of the study program “Computer Systems”. Research in artificial intelligence, focusing on multi-agent systems, software for control of multi-robot systems based on intelligent agents and systems theory. E. Lavendelis has 42 publications in the corresponding field of research (14 of them in the last 6 years) and has participated in 18 research projects (7 of them in the last 6 years), including FP7 and ERA-NET international projects, and has been a scientific leader or RTU research team leader in 3 projects.

Assoc. Prof. Alla Anohina-Naumeca

Primary research area: intelligent learning systems that use artificial intelligence methods to ensure personalised learning process. She has published three research papers in this area in the last six years. She has completed a contract with the IT Education Foundation to develop the content structure of a free online open access study course in artificial intelligence, and at RTU has developed a massive open online course in artificial intelligence, “Artificial Intelligence: Search and its Applications”. In 2020, she completed AI-related courses demonstrating the highest results during her internship at the State University of New York at Buffalo, USA. She has obtained certificates in professional advancement courses “Artificial Intelligence for Everyone” (Coursera), “Elements of Artificial Intelligence” (University of Helsinki) and “Mind and Thinking from a Cognitive Science Perspective” (UL Open Minded).

Prof. Jānis Grundspeņķis

Implements study courses related to artificial intelligence and systems theory. His latest research involves work on four projects: complexity analysis of concept maps from a systems theory perspective, the use of ontologies in competency management, future robotics technologies, and event-based computer vision.

Prof. Oksana Ņikiforova

Within the context of the topics of the implemented study courses (software design and development technologies, innovative product development and entrepreneurship, etc.) she has published more than 100 scientific articles and has participated in more than 30 scientific projects, as well as has long-standing industrial experience in software development projects.

Prof. Mārīte Kirikova

Her research interests are mainly related to requirements engineering. Research is focused on models for representing the context of information systems and the development of a continuous requirements engineering framework to ensure the flexibility of the requirements engineering process. Recent research is related to incorporation of data analytics into the requirements engineering process. During the last six years, she has participated in 4 international and 5 local projects. The results of scientific research over the past six years have been published in more than 75 publications.

Assoc. Prof. Ērika Nazaruka

Her scientific publications are related to the formalisation of the software development process, which allows quality control measures to be taken at the system analysis stage. She has completed the course in automation of software functional testing implemented by Accenture Latvian branch. Maintains close cooperation with A1QA (representative in Latvia “Planet of Testing” LLC) and Accenture Latvian branch representatives is organised in the implementation of the study courses.

Prof. Marina Uhanova

In the last six years, she has published 12 scientific articles and participated in one scientific project related to the study courses she implements (software development and testing). In 2019, she completed an internship at the State University of New York at Buffalo, USA for the purpose of professional advancement, and mastered three Coursera courses: “Text Retrieval and Search Engines”, “Programming for Everybody (Getting Started with Python)” and “Python Data Structures”.

Assoc. Prof. Pāvels Rusakovs

In the last six years, he has published three scientific articles dealing with some of the problems of the Semantic World Wide Web and the use of video steganography for copyright protection.

Assist. Prof. Ilze Birzniece

She has enhanced her competences in data analysis and knowledge extraction over the last two years by working on three ITKC projects and by supervising students' graduation papers dedicated to the topics of the delivered course. In the last six years, 10 articles have been published, 7 of them related to information retrieval, data mining and analytics in different application domains. In 2021, completed the RTU professional advancement program "Data Analysis and Reporting with Python" in the volume of 160 hours.

Assoc. Prof. Gundars Alksnis

Implementing the study course "Methods and Evolution Trends of Applied Computer Science" since 2014, Gundars Alksnis applies the competences acquired in the course of research in the study process, which allows him to comprehensively discuss with the Master students the research in applied computer science carried out at RTU and to provide broader insights into the development trends in applied computer science.

Assoc. Prof. Gints Jēkabsons

He is involved in the research related to the topics of the study courses he implements - machine learning, statistics, optimization, information retrieval. In the last six years, he has published seven scientific articles in the context of these topics and has participated in two research projects. He regularly participates in professional advancement seminars.

Assoc. Prof. Aleksejs Jurenoks

In the last six years he has authored 33 scientific articles and participated in 2 scientific projects.

Assist. Prof. Jānis Eiduks

In the last six years he has authored 2 scientific articles.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, renewal of the academic staff has been considered one of the tasks, which has been completed upon replacement of retiring colleagues with new qualified academic staff. Starting with the academic year 2016/2017, the average age of the academic staff at the Institute of Applied Computer Systems was 49,8 years, but since the academic year 2021/2022 it has been 47,7 years. Generally, the academic staff during the reporting period is estimated as stable.

Generally, young colleagues start their career at the Institute of Applied Computer Systems already during their studies (final semesters of Bachelor studies or Master studies) by getting involved in one of the research projects implemented at the Institute. During their PhD studies, the new academic staff members usually teach undergraduate students, as well as assist in the implementation of the academic Master study program. After obtaining the PhD degree, the young academic staff members are more widely involved in the implementation of Master study program. This mechanism of attracting new academic staff has proven to be very useful in terms of assessing potential candidates during their studies and reaching out to students with the qualities and skills required for academic work, as well as the skill set appropriate for a successful teaching career.

Currently, 18 of the 26 elected academic staff members at the Institute of Applied Computer Systems hold PhD degree, representing ~70% of the elected academic staff.

The field specific study courses are mostly implemented by the academic staff of the departments within the Institute of Applied Computer Systems, whose composition has undergone relatively little change. The changes have been made with one of two objectives:

1. to change the academic staff of a study course in order to improve or modernise the content of the study course. Such changes are based on student feedback and evaluation of the course content.
2. to change the academic staff of a study course who is temporarily or permanently unavailable for the implementation of a particular study course for any reason due to retirement, change of job, or other reason.

Regardless of the reason for the replacement, it is taken into account that the quality of the implementation of the study course must not be reduced by the arrival of a new academic staff. This ensures the quality of the implementation of the entire study program. The effectiveness of this strategy has been attested by the average academic staff evaluation of 4.49 in the autumn semester of 2021, which is very high and at the same time the highest ever assessment received by the study program “Computer Systems”.

At the Department of Artificial Intelligence and Systems Engineering (at the beginning of the reporting period referred to as the Department of Systems Theory and Design):

1. Assoc. Professor Egons Lavendelis has taken over the implementation of study courses “Computer System Design scientific seminar”, “Computer System Design Methods (scientific seminar)” and “Master Thesis”, as well as the position of the Head of the study program from Professor Jānis Grundspeņķis. No significant changes in student feedback have been observed.
2. Assoc. Professor Alla Anohina-Naumeca has become the responsible instructor in the study course “Methods of Systems Theory” by replacing Professor Jānis Grundspeņķis. No significant changes in student feedback have been observed.

At the Department of Software Engineering:

- Instead of Professor Larisa Zaiceva, the study course “Software Metrology and Planning Models” is implemented by Associate Professor Aleksejs Jurenoks. No significant changes in student feedback have been observed.
- Instead of Professor Leonīds Novickis, the study course “Special Data Processing Technologies” is implemented by Professor Marina Uhanova. The new skills and competences acquired by Marina Uhanova were used, which were acquired during the participation in so-called "Buffalo" program, which provides academic staff training at the University of Buffalo, USA. No significant changes in student feedback have been observed.
- Instead of Professor Leonīds Novickis, the study course “Applied Software Systems (scientific seminar)” is implemented by Associate Professor Gints Jēkabsons. No significant changes in student feedback have been observed.
- Instead of Associate Professor Eleonora Latiševa, the study course “Network Software” is implemented by Professor Marina Uhanova. No significant changes in student feedback have been observed.
- Instead of Professor Larisa Zaiceva, the study course “Advanced Software Technologies (scientific seminar)” is implemented by Assoc. Professor Aleksejs Jurenoks. No significant changes in student feedback have been observed.
- Instead of Professor Larisa Zaiceva, the responsible instructor of the study course “Theory of

Software Reliability" is Assoc. Professor Aleksejs Jurenoks and Professor Marina Uhanova participates in the implementation of this study course. No significant changes in student feedback have been observed.

There have been no changes in the team of leading academic staff at the Department of Applied Computer Science, but there has been a rotation of implementing and responsible staff:

- A new course "Testing and Software Quality" has been introduced, Associate Professor Ērika Nazaruka is the responsible instructor. This course replaced the study course "Process Programming", which had been archived due to moral obsolescence. Since the change of the teacher, a markedly positive change in student feedback has been observed.
- The Head of the Department Associate Professor Gundars Alksnis has been appointed as the responsible instructor of the course "Master Thesis", by replacing Professor Uldis Sukovskis. No significant changes in student feedback have been observed.

The fundamentals of engineering, as well as humanities study courses, are provided by other RTU organizational units:

- Instead of Assist. Professor Valērijs Kuņickis, several study courses in humanities are implemented by Assist. Professor Laila Girsova.
- Instead of Assoc. Professor Alvars Baldiņš, the study course "Ethics" is implemented by Associate Professor Gunārs Ozolzīle, whereas the study course in pedagogics is implemented by Professors Alīda Zigmunde and Karine Oganisjana.
- Instead of Assistant Professor Zanda Lejniece and Gunārs Ozolzīle, the study course "Presentation Skills" is implemented by Professor Airisa Šteinberga.

In the case of these academic staff changes, no significant changes in student feedback have been observed.

High turnover of academic staff in the courses in humanities and social sciences may be explained by the fact that they are not specialization courses. Within these courses, students acquire the fundamentals of a particular field, so these courses can be implemented by a range of academic staff.

At the same time, rigorous quality control is applied to the implementation of the study courses. Student feedback is the primary source of information. A trust-based cooperation with the student self-government has been established, so that students can approach not only the head of the study program but also their peers in the student self-government, who in their turn inform the head of the study program. All student complaints are promptly assessed and discussed with the academic staff. If it is found that a member of academic staff is unsuitable to implement the study course in question, solutions are sought to improve quality.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

When defining the curriculum of a study course, the responsible instructor, in collaboration with the head of the study program, assesses the role of the study course in the study program, considering the required background knowledge and providing the necessary foundations for the subsequent courses. All changes in the study program, as well as significant changes in the study courses, are discussed in the Council of the Institute of Applied Computer Systems, which is composed of the heads and representatives of all departments within the Institute. Representatives of each organizational unit consider the proposed changes from the perspective of the courses implemented by their units. As soon as a link between the study courses is identified, a working group is set up, involving the head of the study program, the responsible instructors of all the courses involved and, where appropriate, the heads of the departments implementing the courses. According to the Regulations of the Study Courses Register approved at the Senate meeting on November 25, 2019 (protocol No. 634), the responsible instructor of the study course is a faculty member elected by the RTU competition, who develops the study course and/or supervises the implementation of the study course. The result is that the responsible instructors of all study courses are informed about the curriculum and expected learning outcomes of thematically related study courses, thus avoiding overlapping between the study courses and the omission of important topics from any of the courses in a given field. Changes to the general part of the study program are discussed with the heads of the departments or responsible instructors of the study courses concerned.

In order to get a precise idea of the curriculum, teaching methods and terminology used in colleagues' courses, it is possible to attend their lectures. In order to ensure quality, the study courses are peer observed by another lecturer, thus taking over the good practices and providing feedback to the study course implementer. Open lectures are also organized for the academic staff. Methodological seminars are regularly organized at both Institute of Applied Computer Systems and Faculty level, where academic staff share their positive experience, which helps all academic staff to cope with new challenges. One of the situations when this was particularly relevant was the transition to remote studies at the beginning of the COVID-19 pandemic. In addition to the new circumstances, academic staff also share their experience on other issues such as students' academic integrity, graduation papers, conflict resolution, changes in the approaches of today's young people to their studies, dealing with the students who combine work with studies, etc.

In response to the changes in the procedures, official documents, the most appropriate approach to the nature of the change is chosen in organization of studies, for example, by organizing an information seminar or sending out detailed information about the changes mentioning the person to be contacted for further information.

In general, new academic staff start their academic career at the Institute of Applied Computer Systems by supervising practical and laboratory work or assisting at the lectures. Initially, new academic staff work under the guidance of experienced colleagues, meeting regularly with the responsible instructors to coordinate the curriculum of the classes and the teaching methods to be used, thus ensuring knowledge transfer between the academic staff involved in the implementation of the study program. Gaining experience and receiving a doctoral degree, the new academic staff is also involved in working with master's students.

All academic staff involved in the implementation of the study course have access to teaching materials prepared by the responsible instructor, which can be used both in the classroom and in e-learning courses. Responsible instructors and other experienced academic staff members are also available for consultation on pedagogical methods to be used in the courses, as well as on other issues that arise for new academic staff.

The head of the study program monitors the implementation of the program and the cooperation between the academic staff. One of the tools for identifying problems is student survey that is conducted every semester. If students point at deficiencies in this survey, the head of the study program organizes a meeting between all the academic staff involved with the aim to find a solution to the problem.

The study program is implemented by 20 academic staff members who hold a PhD degree, including 4 professors and 9 associate professors. The number of students per academic staff in the study program is 4.07.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DMD0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_DMD0(45526)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DMD0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DMD0(45526)_AIP_atzinums250stud_Datorsistemas.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DMD0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DMD0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMD0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_DMD0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DMD0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DMD0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DMD0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DMD0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DMD0(45526)_StudyCoursesdescr_ENG.zip	P10_DMD0(45526)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

E-LearningTechnology and Management (51482)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*E-LearningTechnology and Management*
Education classification code	*51482*
Type of the study programme	*Doctoral study programme*
Name of the study programme director	*Atis*
Surname of the study programme director	*Kapenieks*
E-mail of the study programme director	*atis.kapenieks@rtu.lv*
Title of the study programme director	*Dr. Phys.*
Phone of the study programme director	
Goal of the study programme	*To develop interdisciplinary research in technology and educational sciences, thus developing at the international level research in the field of e-learning. To master existing and create new research methods for e-learning and related areas. To prepare specialists of the highest qualification at the 8th level of the Latvian and European Qualifications Framework for the development of large and complex projects, as well as for work in educational and knowledge support institutions according to the needs of tomorrow's knowledge economy.*
Tasks of the study programme	*Carry out research in situations where organizations use information systems to achieve their goals, particularly for learning and human resource development purposes.* *Develop and test theories and models that describe the processes in the development and use of e-learning.* *Carry out research with the aim to create new information systems and methods in the field of e-learning technologies.* *To analyze the scientific literature in the fields of e-learning research and related sciences. Clarify the study tasks taking into account the work of other researchers.*

Results of the study programme	*Will be able to create competitive products in knowledge management, mobile and collaboration technologies, e-products and services.* *Will be able to conduct academic and industrial interdisciplinary research and prepare it for publication in scientific journals.* *Will be able to understand the needs of the knowledge society in the field of e-learning technologies to choose methods to meet these needs.* *Will be able to initiate and prepare national and international eStudy research and development projects and manage such projects or parts thereof.* *Will be able to follow the research and development of e-learning technologies in the world, evaluate the latest solutions and predict their impact.* *Will be able to implement innovative e-learning courses and evaluate the results using the latest e-learning technology findings.* *Will be able to create, develop and implement new ideas in the field of e-learning technologies*
Final examination upon the completion of the study programme	*Doctoral thesis.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*Master degree in engineering science, natural sciences, arts, social sciences or education sciences, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D) in education*
Qualification to be obtained (in english)	-

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*

Admission requirements (in English)	*Master degree in engineering science, natural sciences, arts, social sciences or education sciences, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D) in education*
Qualification to be obtained (in english)	-

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*Master degree in engineering science, natural sciences, arts, social sciences or education sciences, or comparable education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D) in electrical engineering, electronics, information and communication technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*
Admission requirements (in English)	*Master degree in engineering science, natural sciences, arts, social sciences or education sciences, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D) in electrical engineering, electronics, information and communication technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The program is being updated as the knowledge economy and society evolve. It prepares specialists who would be able to master it at a high professional level.

Active research in the field of e-learning technologies has continued since the previous accreditation, related to learning analytics, artificial intelligence, virtual reality, and Big Data. The implementers of the program have participated in several research projects that are closely related to this topic (JAUZI, ARTSS). A new HorizonEurope project "TED4LAT Twinning in Environmental Data and Dynamic Systems Modeling for Latvia" has just been approved. New findings from international level projects are incorporated into the doctoral program by creating new courses and updating course content.

Changes in the course plan

The structure of the program is in accordance with the doctoral program regulations of Riga Technical University:

- *Part A, compulsory subjects – 15 (fifteen) CP;*
- *Part B, compulsory elective subjects – 21 (twenty one) CP;*
- *Part C, optional subjects – 6 (six) CP;*
- *Part E, scientific work – 150 (one hundred and fifty) CP.*

The total number of credit points is estimated at 192 (*one hundred and* ninety two) CP.

No changes have been made to Part A.

Part B is amended as follows:

Courses without changes:

	DSP640	Actualities of of knowledge management	5.0 CP	

The following study courses have been deleted / removed:

Mobile communication systems	5
Telecommunications and computer networks	5
Signal processing theory	5
Actualities of information systems development	10
Structural modelling	10
Modern methods in computer system design	10
Distributed intelligent systems	5

University pedagogy	5
Psychology of sustainable education	5

Creating a learning environment conducive to the development of research capabilities	5
Basic principles of modern education and approaches to their release	
Teacher competence	5
Educational research methodology	5
Modern management theory	5
Change theories and contemporaneity. Strategic planning of organization. An organization capable of learning	5
English or German, or French	6 CP

New courses:

No.	Code	Course title	Engineering sciences	Social Sciences
B		Limited choice study courses	21.0	21.0
B1		Professional specialization study courses	21.0	21.0
1	RTC724	E-study technologies	5.0	
2	RTC725	E-learning data research and analytics	5.0	5.0
3	LTC728	Data quality: methods, tools and techniques (LiepU)	4.0	
4	RTC727	Cyber security and e-learning technologies	4.0	
5	LTC734	Pedagogical strategies for personality socialization (LiepU)		2.0
6	LTC735	Transformative education for self-realization of personality (LiepU)		4.0
7	LTC732	Quality dimensions of the educational environment (LiepU)		4.0

8	LTC729	Educational strategies for research skills (LiepU)		4.0
9	HPS620	Higher education didactics		4.0
10	HPS621	Pedagogical psychology		4.0
11	LTC730	Laboratory of ideas: pedagogical solutions for personality socialization (LiepU)		4.0
12	LTC731	Laboratory of ideas: pedagogical solutions in the context of transformative education (LiepU)		4.0
13	LTC733	Management theory (LiepU)		5.0

Entrance requirements are updated:

Master's degree in natural sciences, master's degree in engineering, master's degree in social science, master's degree in humanities and arts, or higher education diplomas corresponding to the said master's degrees

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

Program implementers actively follow the development of the priorities and directions of the European Framework Program and update the research directions of the doctoral program accordingly.

Program results

Will ensure young doctors with the skills to work internationally, to carry out research in the field of knowledge society technologies and to introduce new knowledge into education. They will provide new knowledge for the introduction of e-Learning technologies in companies and in the lifelong learning system.

The program prepares highly qualified specialists both for the development of large and complex projects and for work in higher education institutions, in accordance with the needs of the future knowledge economy. Higher education institutions plan to develop the main research directions as follow:

- to carry out applied research in sectors important for the development of the Latvian economy;
- to create competitive products in knowledge management, mobile and collaborative technologies, e-products and services designed to increase the efficiency of knowledge economy enterprises, making full use of the potential of technology and knowledge society organizations, as well as the results of interdisciplinary research.

Doctoral students will be able to propose and prepare national and international eStudy research and development projects. They will be qualified to manage such projects or parts of them.

Doctoral students will be able to assess which educational development projects are recommended in specific situations.

E-learning technologies and management is a sub-branch of the Science branch "Electrical engineering, electronics, information and communication technologies".

The duration and scope of the program implemented in English corresponds to the Latvian version.

The form and duration of studies

Full-time studies – 4 years

Degree to be obtained

Doctor of Science (Ph.D) in Electrical Engineering, Electronics, Information and Communication Technologies or Doctor of Science (Ph.D) in Education

Admission requirements

Master's degree in natural sciences, master's degree in engineering, master's degree in social sciences, humanities and arts or higher education diplomas corresponding to the said master's degrees.

The study program has two implementation directions – engineering and social sciences, they have different professional specialization courses in Part B.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

E-learning technologies have been developing rapidly for more than 20 years. If twenty years ago the transfer of traditional educational methods to the digital environment dominated, now the main challenges are related to the educational models of the digital age. In the last ten years, new educational technologies and new research directions have emerged - MOOCs, learning analytics, artificial intelligence, virtual reality, blockchains. The COVID-19 pandemic gave a rapid impetus to the development of e-learning technologies. At the same time, it should be noted that the decisions on digital solutions in the context of COVID-19 were rapid and political - they were not sufficiently based on the findings of e-learning technology researchers. Researchers are currently working to interpret and generalize the educational experience of COVID-19. Rapid development is expected in the future, as a unified model of education in the digital age is still being developed.

The doctoral study program "E-learning technologies and management" prepares highly qualified international level specialists (doctors of science) in the sub-branch of e-learning technologies and management, providing the theoretical and practical knowledge necessary for the implementation and management of independent research work, development of new technologies and for use in the design and implementation of various information systems related to education in the digital age in different educational situations.

The content of the study program and its implementation is based on the existing laws and regulations of the Republic of Latvia, the principles of doctoral education recommended by the European University Association, EQUAL May 2016 guidelines for doctoral studies, considering United Nations Sustainable Development Goals in Higher Education and Strategic Development aims of RTU and its Faculty of E-learning Technologies and Humanities. The uniqueness of the study program is interdisciplinary and transdisciplinary research in different educational situations. The level of technological development and the diversity of scientific challenges create the need and opportunity to acquire a program for doctoral students with different previous education.

The intellectual potential necessary for the economic development of the country is formed in doctoral studies. According to the document “Latvia's Sustainable Development Strategy 2030”, long-term investments in human capital are needed to promote the renewal of human resources, therefore the demand for specialists with a doctoral degree in the labour market in Latvia is very high. The main indicator of demand is the employment of graduates.

Graduates of the doctoral study program are able to establish their own high-tech start-ups, manage Latvian and European scientific and engineering projects in in E-learning technologies both in companies and educational institutions. Graduates of the study program are highly qualified specialists in E-learning technologies and work in Latvian higher education institutions, research institutes, training centers, state institutions and other organizations related to digital age education. Graduates work, for example: at Riga Technical University, Vidzeme University of Applied Sciences, Liepaja University.

Significant developments in education and training markets are taking place in low- and middle-income countries, especially in Africa. Graduates of the doctoral program have already explored new opportunities and prepared a number of digital development projects in sub-Saharan Africa.

During the reporting period 6 doctoral students obtained the doctoral degree.

4 graduates from RTU, 2 graduates from LiepU.
In 2022-2023 8 doctoral students plan to defend their dissertation. 3 doctoral students from RTU, 5 doctoral students from LiepU.

All graduates are employed as lecturers and researchers at the relevant university.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The doctoral study process is based on the individual plan of students and is adapted to the specifics of each student's study, taking into account various factors: family circumstances, mobility and internship abroad, involvement in research projects and pedagogical work, career industry, end of ERDF doctoral grant funding program in 2013, factors caused by the COVID pandemic. Due to the mentioned reasons, doctoral students often choose academic leave, interrupt their studies, do not defend their dissertation at the end of the 4th study year, but continue to develop their dissertation even after the official completion of the study process. Taking into account the high degree of adaptation of the study process, the large number of influencing factors, the statistically small total number of students, the numerically summarized distribution of students is statistically little informative. Fluctuations in the total number of students are directly related to the specifics of the study process organization. However, it should be noted that the average number of students admitted in the reporting period is 2-3. Until now, doctoral dissertations have been defended by all doctoral students who have received ERDF doctoral grant funding for one year.

Several activities are carried out to promote student enrolment, success and graduation:

- Active co-operation with Latvian higher education institutions in order to promote the admission of new doctoral students and the joint management of doctoral students;
- Active cooperation with other RTU institutes in order to promote the enrolment of new doctoral students and the joint management of doctoral students;
- Every year together with the University of Liepaja, Vidzeme University of Applied Sciences and Rēzekne Academy of Technology we organize doctoral schools;
- Every other week we organize scientific seminars at the Distance Education Study Centre, where we discuss current work, the latest research results and development opportunities for the new projects;
- RTU SAM ERDF project funding for doctoral grants both for studies in the 1st and 2nd study year to attract new doctoral students and for studies in the 3rd and 4th study year is aimed at defending doctoral theses; the experience of our program confirms that the SAM grant is an excellent mobilizing factor for the completion and defence of the dissertation;
- Active involvement of doctoral students in research projects (FuturICT2.0 ERA-NET project 2017-2020, ARTSS project 2020-2021, TED4LAT project 2022-2025) gives doctoral students an opportunity to get to know the international scientific space and present their research within the framework of project activities;
- Active work with already deducted doctoral students in order to promote the development and defence of the doctoral thesis already after the completion of doctoral studies;
- Methodological and organizational support for the participation of doctoral students in scientific conferences in order to promote the publication of research results of doctoral students;
- Participation of doctoral students in Horizon Europe events organized by the European Commission. Doctoral students get acquainted with the European Research Area;
- Involvement of doctoral students in the preparation of project applications of the European Commission's Horizon Europe program, these skills give an opportunity to better understand the future development directions of e-learning technologies and develop the ability to create new jobs;

- We have prepared the Horizon Europe TED4LAT project (Twinning in Environmental Data and Dynamic Systems Modelling for Latvia). Within the framework of the project, doctoral student schools in Latvia, Italy and France are planned for 2023, 2024 and 2025. Three-month study visits to Italy (POLITECNICO DI TORINO) and France (INSTITUT NATIONAL DE RECHERCHE POUR L'AGRICULTURE, L'ALIMENTATION ET L'ENVIRONNEMENT)

Every year RTU admits 2-3 doctoral students. Statistical data on the topics of doctoral theses are summarized in Section 3.2.6.

The summary of the survey of doctoral students is attached.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

The program is implemented together with the University of Liepaja, based on the agreement concluded in 2007. The implementers of the program intend to submit the program for licensing as a joint program. Attached is the new draft cooperation agreement between RTU and the University of Liepaja for 2022.

Two programs were created when the Law on Higher Education Institutions did not provide the creation of a joint program. Documentation is currently being prepared to transform both programs as a joint program.

In 2023, it is planned to provide the joint study program for licensing. If the joint program is licensed, then students will transfer to the joint program. When all the students have transfered to the joint program, we estimate that the program will be integrated to new joint programm.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The program is designed to develop international-level interdisciplinary research in technology / e-learning for the knowledge society, which, according to the traditional industrial society sciences, is currently located in various fields of science; enables to acquire existing and create new research methods for e-learning and related fields. The development of research in the field of e-learning goes hand in hand with the development of e-learning itself. Both traditional information technology and educational research methods and Livig Lab methods are used in the research. **Program results** will provide young doctors with the skills to work internationally, conduct research in the field of knowledge society technologies and introduce new knowledge into education. They will provide new knowledge for the introduction of e-Learning technologies in companies and in the lifelong learning system.

The program prepares highly qualified specialists both for the development of large and complex projects and for work in higher education institutions, in accordance with the needs of the future knowledge economy. RTU and the University of Liepaja plan to develop the following main research directions:

- To carry out applied research in sectors important for the development of the Latvian economy in those areas related to the transition to the digital economy;
- To create competitive products in knowledge management, mobile and collaborative technologies, e-products and services designed to increase the efficiency of knowledge economy enterprises, making full use of the potential of technology and knowledge society organizations, and the results of interdisciplinary research.

Doctoral students will be able to propose and prepare national and international eStudy research and development projects. They will be qualified to manage such projects or parts of them.

Doctoral students will be able to assess which educational development projects are recommended in specific situations.

Information included in study courses/modules, achievable results, set goals, etc. the interlinking of the indicators with the goals and achievable results of the study program is shown in the mapping (see appendix P08_3_2_1).

The content of the study courses is updated according to the development trends of the industry, labor market and science. The content of study courses is updated according to research trends in European research and educational development programs.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The interdisciplinary theoretical courses are intended for the in-depth acquisition of the general theoretical basis, research methodology and the structure of the doctoral thesis.

The examination in e - learning technologies covers the latest knowledge, concepts and theories in the field of e - learning technology and management.

Limited elective courses deepen the competence of doctoral students in the chosen research directions. The limited choice exam can be taken together or in parts, depending on the organization of the exam process at the university.

The doctoral student chooses the elective courses from the elective course catalogue approved by the university or from the doctoral courses / summer schools of other world universities in the field of e-learning research. Doctoral students also participate in the preparation and implementation of new e-learning research and development projects. It gives an opportunity to approbate the theoretical and practical knowledge gained during doctoral studies in the development of new e-learning courses or research projects.

Looking at the branches and sub-sectors of science in the EU classification, we see the following:

- Research in e-learning is the part of telematics, which in turn is the part of technology sciences;
- E-content research is the part of IT research;
- Educational multimedia is a research field in the educational sciences.

The doctoral program is also aimed at promoting the transformation of traditional economic sectors on a more productive technical and technological basis, as well as creating new sectors not yet unique in Latvia, created by new knowledge and modern technologies, thus leveling out regional differences in employment and promoting socio-economic development.

The doctoral program in the field of e-learning research develops a holistic approach both by referring to the latest EU science policy documents and the priorities of the Latvian National Development Plan, and by purposefully trying to learn from the mistakes made recently by the world economy (Internet bubble and global crisis).

The doctoral program develops international research in the field of e-learning. It provides an opportunity to acquire existing and create new research methods for e-learning and related fields. The program prepares highly qualified specialists both for the development of large and complex projects and for work in universities, in accordance with the needs of tomorrow's knowledge economy.

The sources of the program are active participation in the projects of the EU 5th, 6th and 7th Framework Programs in order to determine the opportunities and methods that will determine Latvia's success in tomorrow's knowledge economy.

In order to strengthen the capacity of the doctoral program in modern data processing directions, the implementers of the program have submitted and in 2022 received a positive evaluation of the project “Twinning in Environmental Data and Dynamic Systems Modelling for Latvia (TED4LAT)”. This will enable doctoral students to learn dynamic modelling and conduct research at the international level.

RTU and the University of Liepaja plan to develop the following main research directions:

- To carry out applied research in sectors important for the development of the Latvian economy in those areas related to the transition to the digital economy;
- To create competitive products in knowledge management, mobile and collaborative technologies, e-products and services designed to increase the efficiency of knowledge economy enterprises, making full use of the potential of technology and knowledge society organizations, and the results of interdisciplinary research.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is

implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The doctoral study program “E - learning technologies and management” is implemented in the amount of 192 CP in full-time studies (8 semesters).

Studies and research work are carried out according to the doctoral student's individually developed plan, which is approved at the beginning of the studies and is regularly monitored during the studies. The elaboration of a doctoral dissertation is the main work of a doctoral student, where new scientific results must be obtained independently. They must be published and presented in the form of a dissertation. A doctoral dissertation must be prepared for submission to the Promotional Council (Promocijas padome). The main results of the dissertation must be published in appropriate scientific publications and presented at scientific conferences. The development of the dissertation is related to the preparation and submission of appropriate documents. The supervisor accepts the doctoral student's individual plan, advises on the design work, the place of publication and the choice of conferences. The doctoral student is responsible for drawing up all documents.

The evaluation system in the doctoral study program is specified in the RTU Doctoral Studies Regulations, LiepU Regulations on Studies, LiepU Promotion Councils Regulations. The Council of the Doctoral Study Program “E - Study Technologies and Management” coordinates the requirements included in the Regulations and other normative documents of universities.

The study process is implemented according to the principles of student-centered education (https://aic.lv/portal/content/files/Informativs_zinojums_SCL_istenosana_Latvija.pdf).

The methods used for the study program in English are the same as for the study program in Latvian.

The study program is implemented in cooperation with Liepāja University. The Liepāja University academics deliver the number of the study courses.

In accordance with the RTU and LiepU doctoral study regulations, at the end of each study year a doctoral student is **attested** to evaluate the doctoral individual work. The opinion of the department meeting (LiepU) or RTU Faculty of E-study Technologies and Humanities (FETH RTU) on the doctoral student's work is recorded and submitted to the Vice-Rector for Science. In case of repeated negative evaluation, it is decided to deduct the doctoral student (the deduction procedure is organized in accordance with the Regulations for Doctoral Studies).

Requirements for the acquisition of theoretical courses for doctoral studies, their activities and examination forms are included in the course programs. Acquisition of theoretical courses is evaluated in a 10-point system.

The type of doctoral student's study work, evaluation of results and obtained credit points are recorded in the doctoral student's study card.

The procedure for the development and defence of doctoral theses is determined by Cabinet of Ministers Regulation No. 101 “Procedure and Criteria for Awarding a Doctoral Degree (Doctoral)” (27 December 2005). According to the above - mentioned regulations, a doctoral degree is awarded for a particularly significant, original, independently performed scientific qualification work (thematically unified set of scientific publications, dissertation or monograph), which is considered to be a significant contribution to the development of e - learning technologies. The main results of the dissertation must be published and tested at international conferences.

The defence of the doctoral thesis at the Doctoral Council takes place only after its positive evaluation at the State Scientific Qualification Commission. Not later than three months before the defence of the doctoral thesis the applicant submits to the Promotion Council:

- doctoral thesis;
- a summary of the doctoral thesis in Latvian and English;
- confirmation documents regarding the completion of the study program and passing the examinations in the chosen field and in a foreign language;
- autobiography (Curriculum vitae);
- a list of published works and copies thereof.

The Promotion Council sends the submitted doctoral thesis to the commission for evaluation. The Commission evaluates the applicant's work and, if the evaluation is positive, appoints an independent international expert and notifies the Promotion Council. After receiving a positive evaluation of the commission:

- The chairman of the Promotion Council invites three reviewers, one of whom is an expert of this council, and two - from other scientific institutions. The reviewers of the dissertation can be Latvian or foreign scientists who are international level experts in the respective field of science;
- the Promotion Council sends the doctoral thesis (or the summary of the doctoral thesis) to an independent international expert appointed by the commission for reference;
- the Promotion Council shall determine the time of the promotion session and announce it two weeks in advance in the newspaper “Latvijas Vēstnesis” and in the newspaper “Zinātnes Vēstnesis”.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

Internship is not planned.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

The doctoral academic study program covers research in all areas of technological and pedagogical solutions for e-learning in relation to the consequences of sustainable development of society. The aim of the study program is to improve the knowledge and skills necessary for the research work of the e-learning technology and management sub-branch, as well as to prepare the students for independent research.

The studies are based on the doctoral student's individual work plan, which is created taking into account the doctoral student's needs and the specifics of the doctoral thesis. A sample plan is used in the choice of study courses, but the student can create an individual plan, taking into account the connection of the study courses. Students have ample opportunities to plan their studies independently.

The completion of the study courses is registered in the implementation section of the work plan, and the completion is approved by the FETH Scientific Commission. The planned amount of work can be implemented in several semesters.

Assessment of study results at RTU takes place in accordance with the Regulations for Assessment of Study Results and the Regulations for Doctoral Studies of Riga Technical University. It stipulates that the examinations in the compulsory study courses are taken at the examination commission consisting of not less than three persons, one of whom is the lecturer (professor) responsible for the study course and the others - doctors of science with expert rights of the Latvian Council of Science (LZP).

Pedagogical methods, the structure of study courses and assessment methods are chosen by the teaching staff responsible for the study course, according to the specifics of the content of the study course and the study program, as well as the needs of the students. Courses and seminars on the latest teaching and pedagogical methods are organized for the academic staff, as well as attendance of in-service training courses is encouraged both at the faculty's internal events and at RTU and internationally. RTU Centre for Academic Excellence organizes in-service training events for academics. RTU participation in the ERASMUS + program ensures the professional development of the academic staff on an international scale.

The teaching staff must be introduced to the specific evaluation criteria of each study course in the first lesson, they must also be published in the e-learning environment of the study course.

The development of the dissertation is controlled on two levels:

- Regular meetings with the supervisor of the dissertation;
- Reporting to the institute council meeting (first-year students at least twice a semester, students of other courses - at least once a semester).

The study program is implemented in close cooperation with the supervisor of the doctoral thesis. In addition, doctoral students are attested at the end of the study year (in accordance with the RTU Doctoral Regulations). The implementation mechanism of this type of study program allows to ensure the achievement of study results.

Doctoral students are transferred to the next study year by the order of the Dean of the Faculty, based on the decision of the Scientific Commission of the Faculty and observing the following minimum requirements for the preparation of publications and the development of the doctoral thesis:

For a first-year doctoral student:

- At least one scientific article has been published or accepted for publication.

For a second-year doctoral student:

- At least one scientific article published.
- One scientific article published or accepted for publication in a journal.

- The doctoral thesis is prepared in the amount of approximately 30% of the total workload.

For a third-year doctoral student:

- At least one scientific article published.
- One scientific article published in a journal.

The dissertation has been prepared in the amount of approximately 75% of the total workload.

Doctoral theses are defended at the RTU “P-21” Promotion Council, which is entitled to award a doctoral degree in Ph.D. in engineering sub-sectors “E-study technologies” and LiepU Promotion Council in the field of educational sciences.

The developed research and defended doctoral theses have a high added value in the development of science and national economy.

80% of graduates of the doctoral study program continue to work in higher education institutions or provide guest lectures, where the results of research conducted in doctoral theses are also included in the content of the study process, which ensures the transfer and further use of knowledge.

In turn, the majority (about 90%) of the knowledge and know-how obtained in doctoral dissertations are integrated into new research project applications.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The topics of students' doctoral theses (research area) are selected when submitting an application for admission to studies. At the same time, the program director recommends a potential research supervisor and consultants. At the beginning of doctoral studies, each doctoral student is approved by the order of the RTU Vice-Rector for Science, supported by the supervisor of the doctoral thesis.

Research themes of the doctoral study program “E-study technologies and management”: technological solutions of e-learning environment, personalization of e-studies, user interfaces, pedagogical solutions of e-studies, increasing the efficiency of e-studies, e-solutions in society, etc.

The developed study program is focused on solving the issues of these research topics, as it aims to prepare internationally competitive higher education e-learning specialists for academic and scientific work in universities, research centres, as well as for work in public, private and international education and other fields. Institutions that have developed skills related to e-solution technologies are able to critically solve problems, including research and innovation, are able to provide new insights and solutions.

Graduates of the doctoral study program “E-learning technologies and management” have conducted research in the following areas:

<u>Doctoral theses in development process and defended during the reporting period:</u>

Theme	Year	The result, 05.2022

Development and action research of a new e-learning environment learning analytics method “Color code method”	2021	Pre-defended
New e-learning environment learning analytics methods “Research of e-inclusion processes and technological solutions	2021	Defended
Knowledge flow research in e-learning environment	2021	Full-time studies
Ecolinguistic Foundations of Linguistic Culture and Sociolinguistic Peculiarities in the International ESL Classroom based on Task-Based Online Learning	2021	Full-time studies
Formation of secondary school students' self-experience in didactic games	2021	Full-time studies
Technology-based organizational approach of e-pedagogical process	2021	Full-time studies
Development and testing of a competency-based curriculum	2021	Full-time studies
Forecasting of international student flows is rooted in simulation modeling	2020	Full-time studies
Research of machine learning algorithms for the development of e-learning technologies	2019	In preparation
Interactive e-platform for personalized teaching of the subject as a tool to increase student motivation and success	2019	In preparation
E-learning research in maritime education in the digital age	2019	Full-time studies
Modeling of technology-based learning process for cross-cutting competencies in engineering education in the digital age	2019	Full-time studies

Integration and approbation of e-pedagogy methods in the training of multilingual students of translation studies study programs	2018	In preparation
Research and implementation of the principles and paradigms of entertaining education in the process of teaching foreign languages in the digital study environment of the university	2018	In preparation
Knowledge sharing simulation model for promoting sustainable cooperation between adult education institutions and companies	2017	Defended
Innovative teaching of Latvian as a foreign language using e-learning methodology for engineering students	2016	In preparation
Integration of digital methods of text recognition and analysis in the development of language skills of students of the Bachelor of Engineering study program in a foreign language	2016	In preparation
Development of a model of traditional and ICT-based teaching methods that promotes students' learning achievements	2016	Full-time studies
Development of an interdisciplinary e-platform for effective acquisition of knowledge in digital humanities	2015	In preparation
E-learning technologies for intensive balancing training	2015	In preparation
Development of an innovative e-learning methodology for improving the quality of the linguistic output of engineering students	2015	In preparation
Research on knowledge transfer processes in modern urban e-ecosystems	2014	In preparation

Multimedia tools for spatial awareness promotion	2014	In preparation
Development of the reflection stimulating ePortfolio system to enhance learners competences	2014	Defended
Educational activity research in e-learning environment	2013	Defended
Information technology ecosystem model to support the continuing education process	2013	Defended

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU infrastructure support

Infrastructure and infrastructure provision consists of premises for studies and scientific work, library, IT provision.

The necessary premises for studies and scientific work are available for the implementation of the study program, which includes the necessary IT support:

- Renovated lecture halls and computer classes (FETH, Kronvalda boulevard 1, Riga), which include video projection, interactive control panels and a computer for the lecturer.
- New computer class (FETH, Kronvalda boulevard 1, Riga) with high-performance computers and modern software, which also includes video projection, interactive control panels, usability testing hardware and software.
- Video studio (Media Center, Āzenes Str. 12, Rīga) and MOOC study materials laboratory (FETH, Kronvalda boulevard 1, Rīga;), which includes video filming, audio recording, processing, live broadcast organization and interactivity development solutions.
- Biosignal (EEG) measurement system (FETH, Kronvalda boulevard 1, Riga).
- Eye tracing measurement equipment (FETH, Kronvalda boulevard 1, Riga).
- Knowledge perception monitoring technology and IT support.

As a part of the IT provision, students will have access to the RTU computer network (access using EDUROAM) with a licensed office, etc. software, including online virtual labs, installed computer programs, and data processing tools. Students will be provided with access to the Moodle (part of the RTU portal ORTUS) e-learning environment, Open-Edx, SAKAI, Open-OLAT, CANVAS, and TELECI e-learning environments and platforms for providing the learning process in the form of distance learning and face-to-face support. Students will have access to a variety of application solutions in the computer classroom and on smart devices in the learning process.

RTU Information support and library

Students will gain access to the ORTUS portal, which contains all the information necessary to ensure the study process, incl. normative documents, lists of lectures, contact information of the academic and support staff, topicalities of the study process. Students will be assigned RTU e-mail addresses, which will be used to communicate with the academic and support staff of the respective university, as well as to receive current information.

Links to modern e-learning platforms and environments will be available on the RTU portal (ORTUS), which will be used to release program courses. At the beginning of the course, the lecturers will introduce them to the students. MOODLE, SAKAI, Open-Edx, Open-OLAT, CANVAS and TELECI e-learning environments according to e-Big3 technology, which includes mobile, stationary and public broadcasting, will be available for uploading independent work, studying lecture recordings and performing training tasks.

The documents required by the student (regulations, policies, procedures) will be available to the student throughout the studies and will be compiled and maintained on the RTU portal ORTUS.

Students, academic staff, researchers will have access to the RTU Scientific Library, which is fitted with modern equipment and technologies and provides various services:

- books, magazines, databases and other electronic resources;
- remote access to electronic resources 24/7;
- 24-hour reading room, which is available to students using the RTU student card;
- electronic joint catalog of the largest university libraries;
- the unified search tool PRIMO (information is searched simultaneously in the catalog and subscribed databases);
- SBA - interlibrary loan;
- information literacy lectures, classes, consultations, trainings, etc.

The library's information source fund includes about 3 000 000 items in various languages, incl.:

- books and book collections;
- periodicals;
- reference literature;
- collection of audiovisual materials;
- electronic databases (SCOPUS, Web of Science, EBSCO).

The library provides trials of new databases. Every year RTU subscribes to the most important databases of scientific articles according to the needs of the faculties. According to the goals of the study program, students have access to such electronic databases as SCOPUS, Web of Science, EBSCO.

n order to update the content of the study literature, the teaching staff of the Distance Learning Study Center develops and updates teaching aids. Students have at their disposal RTU and FETH information repositories:

- Repository of books and periodicals of RTU Scientific Library,
- Resources of the Faculty of E-learning Technologies and Humanities,
- Resources and literature collections of the RTU structural units involved in the

implementation of the program.

During the implementation of the study program, open technologies and open learning resources will be used, creating a wide knowledge base in the field of e-learning technologies and promoting the development of distance learning. The implementation of the study program will allow to integrate into the RTU information provision the results of research in the field of e-learning technology, which have been created at RTU and in the world during the last 20 years.

RTU methodological support

At the beginning of the study course, students will be introduced to the study course procedures, the requirements for acquiring the study course and the preliminary knowledge required for its acquisition, as well as the study work plan in each study course and the student's knowledge assessment methods and criteria. Study materials, including the description of the study course and the requirements for the acquisition of the study course will be available to the student throughout the whole study course.

Methodologically, the program is provided based on the concept of student-centered education: the individual needs of the student are taken into account. The study results are formulated both for the whole program and for each individual study course. Study credit points are related to study results. The set of results of the individual courses forms the study results of the program. Achieving study results as a process, and the study results themselves are the central issue in the periodic internal evaluation of the study program - audit. As a result, students know and understand what the intended learning outcomes are.

The criteria for assessing students' progress and marking are based on the results assessed with a mark, showing whether and to what extent the study results have been achieved.

The methodological concept of the study program envisages the use of very diverse study technologies and very wide diversity in the study process. This approach opens the possibility to achieve results in various ways, including in lifelong learning. Knowing the learning outcomes to be achieved leads to greater understanding among students, employers and society at large at international level, between education systems. Dialogue is becoming possible between all parties.

The RTU study process is regulated by the RTU Study Regulations, as well as the Code of Academic Integrity has been adopted to strengthen RTU's academic culture and integrity *(https://www.rtu.lv/writable/public_files/RTU_rtu_studiju_reglaments_7.1.1.4..pdf).*

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

The study and scientific base support is developed at the international level. Almost all the latest technologies with potential for e-learning research and development are available within RTU and LiepU international projects.

In cooperation with the University of Liepaja, doctoral students are provided with study courses and teaching staff in the fields of educational science.

We are organizing join doctoral schools in cooperation with the Daugavpils University, Vidzeme University of Applied Sciences, Rezekne Academy of Technology and University of Liepaja.

To ensure the advanced research development in the fields of data analytics and dynamic modeling we have designed joined Horizon Europe Programme project TED4LAT. This project will strongly upgrade data analytics and dynamic modelling research in doctoral programm. We are cooperating with Vidzeme University of Applied Sciences, University of Liepaja, University Politecnico di Torino, Institut National de Recherche Pour L'Agriculute, L'Alimentation et L'Environnement (INRAE).

The Promotion Council includes representatives from the University of Latvia, Rēzekne Academy of Technology, Liepāja University and Vidzeme University of Applied Sciences.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU funding from state budget consists of study base funding which corresponds to the list of study programs and the number of students and consists of funds for utility payments, taxes, infrastructure maintenance for the purchase of inventory and equipment, and staff salaries, as well as funding for research activities.

Study base funding from the state budget is allocated for full-time studies. The amount of funding for the study base is determined on the basis of the number of study places determined by the state at RTU, as well as the base costs of the study place determined by the state and the study cost coefficients for the thematic areas of education. The study cost coefficients of the thematic areas of education are indicators that determine the amount of study place costs in the respective thematic field of education in relation to the base costs of the study place.

RTU has a decentralized budget and a separate budget is planned for each structural unit. RTU's revenues and expenditures are managed according to the principles approved by the Senate or determined by the Vice-Rector for Finance.

Funding for the departments is allocated either according to the financial or budgetary year or immediately after receipt of the funding. At RTU, each head of a structural unit is provided with remote access to operative financial information on the budget of the structural unit, including the planned scope of work and the corresponding allocation of funding in future periods for the implementation of study programs and study courses. Based on this information, the head of the structural unit plans the work of the structural unit at the beginning of each financial or budget year, incl. remuneration issues for the academic staff, which is subordinated to the specific head of the structural unit, and developing a procurement plan for the next year in accordance with the study program or study course to ensure the operation and development, etc.

The following table shows the main sources of funding for the program:

Study year	State budget financing, EUR	Total funding for the program, EUR (no income from tuition fees)	Financing of one state budget place, EUR
2012/2013	17 467	17 467	8153
2014./2015	19 272	19 272	11598
2015./2016	25 090	25 090	5599
2016./2017	63 851	63 851	11598
2017./2018	68 473	68 473	12 122
2018./2019	71 342	71 342	12 689
2019./2020	78 342	78 342	13 215

Information on the distribution of funding between cost items is provided in the appendix to the self-assessment report "Distribution of funding between cost items".

A significant part of additional funding is provided by international and national research projects. It ensures the development of infrastructure, the creation of new areas of research, as well as, as far as possible, the remuneration of doctoral students for work on research projects.

Information on the minimum required number of students in the program is given in the appendix to the self-assessment report “On the minimal number of students in study programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The involved teachers and the corresponding study courses are given in the table:

Study course	Teaching staff	Scientific degree	Position	LZP expert	Zinātnes nozare
RTC724 RTC725 RTC601 RTC009	Atis Kapenieks	Dr.phys.	associated professor	25.05.2023	Engineering Sciences and Technologies-Electrical Engineering, Electronics, Information and Communication Technologies
RTC601 RTC009 RTC725	Jānis Kapenieks	Dr.paed.	Senior researcher	30.06.2024	Engineering Sciences and Technologies-Electrical Engineering, Electronics, Information and Communication Technologies
RTC601	Lāsma Ulmane-Ozoliņa	Dr.paed	lecturer		
RTC725 RTC009	Sarma Cakula	Dr.paed.	professor	31.03.2024.	Engineering Sciences and Technologies-Electrical Engineering, Electronics, Information and Communication Technologies
RTC725	Ieva Vītoliņa,	PhD	researcher		
RTC727	Valdis Vītoliņš	Dr. comp.	guest lecturer		
DSP640	Mārīte Kirikova	Dr.sc.ing.	professor	06.04.2025.	Engineering Sciences and Technologies-Electrical Engineering, Electronics, Information and Communication Technologies

RTC009 LTC728	Anita Jansone	Dr. comp.	professor	31.03.2024. 24.03.2023.	1. Engineering Sciences and Technologies-Electrical Engineering, Electronics, Information and Communication Technologies 2. Natural Sciences-Computer Science and Informatics
LTC734, LTC730	Lāsma Latsone	PhD sociālās zinātnes	researcher	04.05.2025	Social Sciences-Educational Sciences
LTC733	Iveta Cīrule	Dr. oec.	pētniece		
LTC735 LTC731	Linda Pavitola	Dr. paed.	professor	06.04.2025.	Social Sciences-Educational Sciences
LTC735 LTC731	Dina Bethere	Dr.paed.	professor		
LTC732	Inga Zeide	PhD	lecturer		
LTC729	Pāvels Jurs	Dr.paed.	professor	17.06.2023.	Social Sciences-Educational Sciences
HPS620, HPS621 RTC009	Airisa Šteinberga	Dr. phys.	associete professor	19.02.2023.	Social Sciences-Psychology
RTC009	Marina Platonova	Dr. philol.	professor	18.09.2022	Humanities and Arts-Linguistics and Literary Studies
RTC009	Larisa Iļjinska	Dr. philol.	professor		
RTC009 RTC727	Aleksandrs Gorbunovs	Dr.sc.ing.	senior researcher		

RTU, LiepU and ViA lecturers are involved in the implementation of the study program. In order to provide a sufficiently wide range of research for doctoral students, a relatively large number of academic staff is included in the study program. The qualifications of the teaching staff comply with the conditions for the implementation of the study program and the requirements of regulatory enactments. The teaching staff has a doctoral degree, a position of professor, associate professor, leading researcher, researcher or lecturer. The table shows the date by which the teaching staff are experts of the Scientific Council.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

In 2013, 5 lecturers were involved in the doctoral study process: 3 professors, 1 leading researcher, 1 researcher. The average age of the staff is 60.8 years. In 2022, 8 lecturers were also involved in the doctoral study process: 3 professors, 3 assoc. professors, 2 leading researchers. The average age of the staff is 60.3 years. The staff has become younger.

In general, the staff was renewed and actively involved in scientific activities, managing and implementing scientific projects related to the development of modern e-learning technologies. New e-learning technology solutions were sought within the projects. In the previous period, the brightest results are related to the creation of interactive television technology (EU FP6 project ELU / Enhanced Learning Unlimited), the creation of multi-screen eStudy Technologies (Projects eBig3 and ETM), as well as the organization of large-scale teacher training. During this period, we received the BOLDIC 2013 Award for eBig3 - Best E-Learning Innovation in Scandinavia and the Baltics in 2013. We also received the Riga Innovation Award in 2009.

After 2013, the brightest research directions are related to data analysis, learning analytics and the organization of large-scale teacher courses in areas related to modern technologies. We created a new technology for monitoring and visualizing the perception of knowledge. For the first time, our article was cited more than 100 times during the year (currently 170 citations). In 2022, we received a letter of commendation from the Latvian Academy of Sciences for our work of the last decade “Interdisciplinary research on how to transform traditional e-learning technology into a real learning ecosystem of the Digital Age”.

In order to ensure further research development, in 2021 we have prepared the Horizon Europe program project “Twinning in Environmental Data and Dynamic Systems Modelling for Latvia / TED4LAT”. The project was highly rated (14 points out of 15) by EC experts and has been nominated for funding. Within the framework of the project, RTU lecturers and doctoral students will learn new data processing and dynamic modelling methods. The TED4LAT project will provide an opportunity to attract doctoral students, new lecturers and modernize the E-learning technology research direction for the further development of the program.

Distribution of teaching staff (student supervisors) for 2022					
No.	**Name, surname**	**Full years**	**Scientific degree**	**Position**	**Deadline for election to an academic position**
1.	Atis Kapenieks	71	Dr.phys.	Assoc. Prof.	04.10.2022
2.	Airisa Šteinberga	54	Dr.psych	Assoc. Prof.; Senior researcher.	11.12.2024; 07.01.2025.
3.	Anita Jansone	56	Dr.sc.ing	Assoc. Prof.	07.11.2022
4.	Sarma Cakula	61	Dr.paed.	Guest Professor	02.02.2026
5.	Jānis Kapenieks	66	Dr.Paed.	Senioer resarcher	20.06.2023

6.	Marina Platonova	41	Dr. philol.	Senior researcher; Professor	05.04.2028; 18.12.2022
7.	Larisa Iļinska	76	Dr. philol.	Senior researcher; Professor	05.04.2028; 15.05.2028
8.	Aleksandrs Gorbunovs	58	Dr.sc.ing	Senior researcher	20.06.2023

Distribution of teaching staff for 2013

No.	Name, surname	Full years	Scientific degree	Position
1	Atis Kapenieks	62	Dr. Phys	Senior researcher
2	Ilmārs Slaidiņš	65	Dr.sc.ing.	Professor
3	Mārīte Kirikova	54	Dr.sc.ing.	Professor
4	Sarma Cakula	53	Dr.Paed.	Guest Professor
5	Mērija Jirgensons	70	PhD.	Researcher

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

During the reporting period, the list of publications of the teaching staff of the RTU Distance Education Study Centre published in journals indexed in the Scopus or WoS databases, is given below.

2012

Jonhson J., Buckingham Shum S., Willis A., Swithenby S., Zamenopoulos T., MacKay R., Lorincz A., Costea C., Bourgine P., Louca J., Kapenieks A., Kelley P., Caird S., Bromley J., Deakin Crick R., Goldspink C., Bishop S., Helbing D. The FuturICT Education Accelerator // European Journal of Physics. - 2012. (2012) pp. 1.-27.

Kapenieks A., Žuga B., Štāle G., Jirgensons M. eEcosystem Driven eLearning vs Technology Driven e-Learning // 4th International Conference on Computer Supported Education (CSEDU 2012): Proceedings, Portugal, Porto, 16.-18. april, 2012. – pp. 436.-439.

Kapenieks A., Žuga B., Štāle G., Jirgensons M. Internet, Television and Mobile Technologies for Innovative iLearning // Sabiedrība, integrācija, izglītība: Starptautiskās zinātniskās konferences materiāli. 1.daļa: Skolas pedagoģija, Augstskolu pedagoģija, Mūžizglītība, Latvija, Rēzekne, 25.-26. maijs, 2012. - 303.-311. lpp.

2013

Vītoliņa, I., Kapenieks, A. e-Inclusion and Knowledge Flows in e-Course Delivery. In: Proc. of 5th Int. Conf. on Computer Supported Education (CSEDU 2013), Germany, Aachen, 6-7 May, 2013. Aachen: 2013, pp. 417-422.

Gorbunovs, A., Kapenieks, A. An Effect of ePortfolio System on Competence Improvement at the Different Stages of the Course. In: Proc. of the 6th Int. Scientific Conf.: Rural Environment. Education. Personality. (REEP), Latvia, Jelgava, 20-21 March, 2013. Jelgava: Latvia University of Agriculture, 2013, pp. 200-206.

Gorbunovs, A., Kapenieks, A., Kudiņa, I. Advancement of E-Portfolio System to Improve Competence Levels. In: Proc. of Int. Scientific Conf. “Society, Integration, Education”, Latvia, Rēzekne, 24-25 May, 2013. Rēzekne: Rēzeknes Augstskola, 2013, pp.61-72.

Gorbunovs, A., Kapenieks, A., Kudiņa, I. Competence Development in Combined Assessment and Collaborative E-Portfolio Information System. Procedia Computer Science, 2013, Vol.26, 79.-100.lpp. ISSN 1877-0509.

Vītoliņa, I., Kapenieks, A. E-Inclusion Measurement by E-Learning Course Delivery. Procedia Computer Science, 2013, Vol.26, 101.-112.lpp. ISSN 1877-0509.

2014

Kapenieks, A., Žuga, B., Vītoliņa, I., Kapenieks, J., Gorbunovs, A., Jirgensons, M., Kapenieks, J., Kudiņa, I., Kapenieks, K., Gulbis, R., Balode, A. Piloting the eBig3: A Triple-screen e-Learning Approach. No: Proceedings of the 6th International Conference on Computer Supported Education (CSEDU 2014), Vol.1, Spānija, Barcelona, 1.-3. aprīlis, 2014. [S.l.]: SciTePress, 2014, 325.-329.lpp. ISBN 978-989-758-020-8. Pieejams: doi:10.5220/0004848603250329

2015

Gorbunovs, A., Kapenieks, A., Žuga, B., Gulbis, R., Kapenieks, K., Kudiņa, I. Conceptual Design and Model of the Feedback Solutions in the Adaptive Integrated Technological Systems. No: Proceedings of the 11th International Scientific Conference eLearning and Software for Education (eLSE-2015), Rumānija, Bucharest, 23.-24. aprīlis, 2015. Bucharest: "Carol I" National Defence University Publishing House, 2015, 1.-6.lpp. ISSN 2343-7669.

Gorbunovs, A., Žuga, B., Kapenieks, J., Kapenieks, A., Gulbis, R., Timšāns, Ž. Actualities of Balance Diagnostics System Model Development for Persons with Disabilities. No: Environment. Technology. Resources : Proceedings of the 10th International Scientific and Practical Conference, Latvija, Rēzekne, 18.-20. jūnijs, 2015. Rezekne: Rēzeknes Augstskola, 2015, 65.-70.lpp. ISBN 978-9984-44-173-3. ISSN 1691-5402. e-ISSN 2256-070X. Pieejams: doi:10.17770/etr2015vol3.185

Kapenieks, A., Žuga, B., Gorbunovs, A., Jirgensons, M., Kapenieks, J., Kapenieks, J., Vītoliņa, I., Majore, G., Jākobsone-Šnepste, G., Kudiņa, I., Kapenieks, K., Timšāns, Ž., Gulbis, R., Tomsons, D., Ulmane-Ozoliņa, L., Letinskis, J., Balode, A. User Behavior in Multi-Screen Elearning. Procedia Computer Science, 2015, Vol.-: International Conference on Communication, Management and Information Technology (ICCMIT 2015), 33.-33.lpp. ISSN 1877-0509.

Žuga, B., Kapenieks, A., Gorbunovs, A., Jirgensons, M., Kapenieks, J., Kapenieks, J., Vītoliņa, I., Jākobsone-Šnepste, G., Kudiņa, I., Kapenieks, K., Timšāns, Ž., Gulbis, R. Concept of Learner Behaviour Data Based Learning Support. Procedia Computer Science, 2015, 43, 134.-140.lpp. ISSN 1877-0509.

2016

Dzelzkaleja L., Kapenieks J. (2016), Real-time Color Codes for Assessing Learning Process, Procedia: Social Science and Behaviour, vol 261, 2016, pp 236-269. (Science Direct)

Kapenieks, J. (2016) Educational action research for the improvement of most required future competencies. Journal of Teacher Education for Sustainability. ISSN 1691-4147, 2016. SCOPUS, accepted for publication.

Osis, K., Cakula, S., Kapenieks, A. Actual Demands Based Knowledge Intensive Technological Model for Life Long Learning Development in Vidzeme Region. International Journal of Education and Information Technologies, 2016, Vol.10, 25.-30.lpp. ISSN 2074-1316.

Cakula, S., Osis, K., Kapenieks, A. Lifelong Learning Management System in Vidzeme Region. No: Society. Integration. Education: Proceedings of the International Scientific Conference. Vol.2, Latvija, Rezekne, 27.-28. maijs, 2016. Rezekne: Rezekne Academy of Technologies, 2016, 517.-526.lpp. ISSN 2256-0629. Pieejams: doi:10.17770/sie2016vol2.1416

Gorbunovs, A., Kapenieks, A., Cakula, S. Self-Discipline as a Key Indicator to Improve Learning Outcomes in E-Learning Environment. Procedia - Social and Behavioral Sciences, 2016, Vol.231, 256.-262.lpp. ISSN 1877-0428. Pieejams: doi:10.1016/j.sbspro.2016.09.100

2017

Gorbunovs, A., Timšāns, Ž., Kapenieks, A., Gulbis, R. Development of Human Balance Capability Testing Prototype. No: Vide. Tehnoloģija. Resursi : XI starptautiskās zinātniski praktiskās konferences materiāli = Environment. Technology. Resources : Proceedings of the 11th International Scientific and Practical Conference, Latvija, Rēzekne, 15.-17. jūnijs, 2017. Rēzekne: Rēzeknes Tehnoloģiju akadēmija, 2017, 62.-68.lpp. ISSN 1691-5402. e-ISSN 2256-070X. Pieejams: doi:10.17770/etr2017vol3.2518

Gorbunovs, A., Kapenieks, A., Ļubkina, V. Human Balance Function Diagnostic and Improvement Model within Social Telerehabilitation System. Social Welfare: Interdisciplinary Approach, 2017, Vol.1, No.7, 76.-87.lpp. ISSN 2029-7424. e-ISSN 2424-3876. Pieejams: doi:10.21277/sw.v1i7.287

2018

Dzelzkalēja, L., Kapenieks, J. Contradictions in Higher Education. Journal of Teacher Education for Sustainability, 2018, Vol. 20, No. 1, pp.124-144. e-ISSN 1691-5534. Available from: doi:10.2478/jtes-2018-0008

Jirgensons, M., Kapenieks, J. Blockchain and the Future of Digital Learning Credential Assessment and Management. Journal of Teacher Education for Sustainability, 2018, Vol. 20, No. 1, pp.145-156. ISSN 1691-4147. e-ISSN 1691-5534. Available from: doi:10.2478/jtes-2018-0009

Gintere, I., Zagorskis, V., Kapenieks, A. Concepts of e-Learning Accessibility Improvement – Codes of New Media Art and User Behavior Study. No: Proceedings of the 10th International Conference on

Computer Supported Education, Portugāle, Funchal, Madeira, 15.-17. marts, 2018. Portugāle: 2018, 426.-431.lpp. ISBN 978-989-758-291-2.

Zagorskis, V., Kapenieks, A. Impact of LMS Selection on Students’ Activity Students’ Activity Evaluation Problems in Moodle and Open edX Learning Management Systems. No: Proceedings of the 10th International Conference on Computer Supported Education, Portugāle, Funchal, Madeira, 15.-17. marts, 2018. Portugāle: 2018, 505.-512.lpp. ISBN 978-989-758-291-2.

Daugule, I., Kapenieks, A. The Data of the Initial Motivation – A Valuable Source for the Development of the Course Content. A Case Study in the Group of Business Students. International Journal of Engineering & Technology, 2018, Vol.7, No.2.28, 89.-94.lpp. ISSN 2227-524X. Pieejams: doi:10.14419/ijet.v7i2.28.12886

Zagorskis, V., Kapenieks, A. Virtual Student - Cognitive Energy Flow Model. No: *2018 Advances in Wireless and Optical Communications (RTUWO 2018)*, Latvija, Riga, 15.-16. novembris, 2018. Piscataway: IEEE, 2018, 1.-7.lpp. ISBN 978-1-5386-5559-7. e-ISBN 978-1-5386-5558-0.

Zagorskis, V., Kapenieks, A., Gorbunovs, A., Kadakovska, Z. Cognitive Energy Flow Model Concept for Virtual Student. In: *CELDA 2018: 15th International Conference on Cognition and Exploratory Learning in Digital Age: Proceedings*, Hungary, Budapest, 21-23 October, 2018. Budapest: -, 2018, pp.358-362. ISBN 978-989-8533-81-4.

Delerue, N., Metral, E., Kapenieks, A., Torims, T. A Massive Open Online Course about Particle Accelerators. No: *9th International Particle Accelerator Conference (IPAC2018): Proceedings*, Kanāda, Vancouver, 6.-6. maijs, 2018. Vancouver: IPAC2018, 2018, 512.-515.lpp. ISBN 978-3-95450-184-7. Pieejams: doi:10.18429/JACoW-IPAC2018-MOPML050

2019

Dzelzkalēja, L., Ipatovs, A., Kapenieks, J. Color Codes: Comparative Conclusions. Periodicals of Engineering and Natural Sciences, 2019, Vol. 7, No. 1, pp.171-176. ISSN 2303-4521. Available from: doi:10.21533/pen.v7i1.404

Juškaite, L., Ipatovs, A., Kapenieks, A. Mobile Technologies in Physics Education in Latvian Secondary Schools. *Periodicals of Engineering and Natural Sciences*, 2019, Vol. 7, No. 1, pp.187-196. ISSN 2303-4521.

Zagorskis, V., Kapenieks, A., Gorbunovs, A. Emotions Identification Utilizing Periodic Handwriting on Mobile Surfaces. *Periodicals of Engineering and Natural Sciences*, 2019, Vol. 7, No. 1, pp.228-237. ISSN 2303-4521.

Kapenieks, A., Daugule, I. Knowledge Flow Analysis: The Quantitative Method for Knowledge Stickiness Analysis in Online Course. *Periodicals of Engineering and Natural Sciences*, 2019, Vol. 7, No. 1, pp.3304-3311. ISSN 2303-4521. Available from: doi:10.21533/pen.v7i1.358

2020

Zagorskis, V., Lavrinoviča, I., Kapenieks, A. First Insights into Hybrid AI-Fuzzy Tutoring System for Boredom Identification. In: Proceedings of the 12th International Conference on Computer Supported Education (Vol.2), Czech Republic, Prague, 2-4 May, 2020, SCITEPRESS-Science and Technology Publications, Lda.,2020, pp.320-326. ISBN 978-989-758-417-6

Juškaite, L., Šteinberga, A., Kapenieks, A. Modern Digital Assessment Systems & Tools: the Measurement of Student Ability & Human Factor Exclusion. In: *INTED 2020 Proceedings: 14th Anternational Technology, Education and Development Conference (INTED2019)*, Spain, Valensija, 2-4 March, 2020. Valencia: IATED Academy, 2020, pp.4677-4683. ISBN 978-84-09-17939-8. ISSN

2340-1079. Available from: doi:10.21125/inted.2020

Kapenieks A., Daugule I., Kapenieks K., Zagorskis V., Kapenieks J. jun., Timsans Z., Vitolina I. Knowledge Acquisition Data Visualization in eLearning Delivery. Proceedings of 12th International Conference on Computer Supported Education - Volume 2: CSEDU, 507-513,2020.

Kapenieks A., Daugule I., Kapenieks A., Zagorskis V., Kapenieks J. Jr., Timsans Z., Vitolina I. TELECI Approach for e-Learning User Behavior Data Visualization and Learning Support Algorithm. Baltic J. Modern Computing, Vol. 8 (2020), No. 1, 129-142.

2021

Gorbunovs, A. (2021). Learners engagement improving and fatigue prevention model based on the analysis of their eye movement traces. In: Proceedings of the International scientific conference "eLearning and Software for Education (eLSE-2021)", Bucharest, Romania, 22-23 April, 2021, Vol. 2, pp. 155-166, doi 10.12753/2066-026X-21-090 [indexed in **SCOPUS**].

Gorbunovs, A. (2021). The Review on Eye Tracking Technology Application in Digital Learning Environments. In: Baltic Journal of Modern Computing, Vol.9, No.1, pp.1-24, https://doi.org/10.22364/bjmc.2021.9.1.01 [indexed in **SCOPUS** and **WoS**].

Kapenieks, J.,sr., Kapenieks, J.,jr. (2021) Information System for Personalized Spaced e-Learning Baltic Journal of Modern Computing, Vol. 12 (2021)

Kapenieks Sr, J., & Kapenieks Jr, J. (2021). Spaced Learning Solution in the e-Learning Environment. In CSEDU (2) (pp. 169-176).

Vitolina I., Kapenieks A. (2021). E inclusion prediction modelling in blended learning courses. Educating Engineers for Future Industrial Revolutions: Proceedings of the 23rd International Conference on Interactive Collaborative Learning (ICL2020), Volume 1, 23, pp. 327–337.

Vītoliņa I., Kapenieks A. (2021). Comparison of e inclusion prediction models in blended learning courses. Proceedings of the 19th International Conference on e-Society (ES 2021), pp. 101–108.

Vītoliņa I., Kapenieks A., Grada I. (2021). Modeling the e inclusion prediction system. Proceedings of the 13th International Conference on Computer Supported Education CSEDU 2021, Vol. 2, pp. 258–265

Information about 10 teaching staff personnel, included in the database of experts of the Latvian Council of Science, is given in 3.4.1. section.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

In May 2022, a new Horizon Europe project "TED4LAT Twinning in Environmental Data and Dynamic Systems Modelling for Latvia" was approved, in which the lecturers involved in the doctoral study program plan to participate. The share of RTU funding is 1.2 million EUR, the share of financing of the University of Liepaja is 0.4 mln. EUR.

Involvement of RTU Distance Education Study Centre academic staff in research projects.

Involvement of **Atis Kapenieks** in research projects:

1. ERDF project - E-technologies in innovative knowledge source and flow systems (in Latvian: E-tehnoloģijas inovatīvās zināšanu avotu un plūsmu sistēmās (ETM)) - project scientific manager, RTU budget: EUR 436 210.
2. EU 7th Framework Program project - ICT Policy Support Program (ICT PSP). ICT for energy efficiency and sustainability in urban areas - project manager in Latvia (RTU).
3. ESF project - Increasing the theoretical knowledge and practical competencies of teachers of vocational subjects and practice managers - project expert, RTU budget: about EUR 30 000
4. ESF project - Continuing education of general education teachers (in Latvian: Vispārējās izglītības pedagogu tālākizglītība) - project expert, RTU budget: about EUR 30 000.
5. Latvian-Lithuanian Cross-border program project LatLit - Synergetic approach with eLearning, TV and mobile technologies to promote new business developments (in Latvian: Sinerģētiska pieeja jaunu biznesu veicināšanai izmantojot e-studiju, televīziju un mobilo tehnoloģiju iespējas (eBig3) - Project Manager, RTU budget – EUR 94 485,00.
6. EU 6th Framework Program project - ELU (Enhanced Learning Unlimited), project manager in Latvia.
7. ERDF Project - New Algorithms for Interpreting User Behavior for Radical Knowledge Transfer in the Ecosystem (in Latvian: Jauni lietotāju uzvedības interpretācijas algoritmi radikālai zināšanu pārneses uzlabošanai eEkosistēmā - JAUZI), Project Manager, Total project budget: EUR 580 531.
8. National research program INOSOCTEREHI, the 2nd project - Development, approbation and implementation of new prototypes, innovative methodologies (approaches, methods, techniques, techniques) in social rehabilitation for the provision of new services, project expert.
9. CERN project - Accelerator research and innovation for science and society in Europe (ARIES) (in Latvian: Paātrinātāja pētniecība un inovācijas Eiropas zinātnes un sabiedrības attīstībai), expert.
10. ERA-NET project - FuturICT 2.0 - Large-scale experiments and simulations of the second generation of future ICT (in Latvian: Plaša mēroga eksperimenti un simulācijas otrās paaudzes nākotnes IKT), expert, RTU budget: EUR 202 200 EUR, Total: EUR 322 0432,38 EUR.
11. Erasmus+ project - Master of Educational Technology: A new online blended learning program for the new Member States (in Latvian: Izglītības tehnoloģiju maģistrs: Jauna tiešsaistes kombinētā mācību programma jaunajām dalībvalstīm), EduTech, expert, RTU budget EUR 46 000.

Involvement of **Janis Kapenieks (sn.)** in research projects:

1. Postdoctoral research activities supported by the European Regional

Development Fund within the Activity 1.1.1.2 “Post-doctoral Research Aid” of the Specific Aid Objective 1.1.1 “To increase the research and innovative capacity of scientific institutions of Latvia and the ability to attract external financing, investing in human resources and infrastructure” of the Operational Programme “Growth and Employment”, project “E-learning technology research in "spaced learning" situations” (in Latvian: “E-studiju tehnoloģiju pētījumi "spaced learning" situācijās”) –01.01.2019-31.12.2021.

2. The 7th Framework Program, ERA-NET project - FuturICT 2.0 - Large-scale experiments and simulations of the second generation of future ICT (in Latvian: Plaša mēroga eksperimenti un simulācijas otrās paaudzes nākotnes IKT), coordinator – 01.01.2017-2018;
3. ERDF project “Technological learning e-ecosystem with random interactions - TELECI”, work package (WP) manager (agreement No.1.1.1.1./16/A/154), work package (WP) manager 01.01.2017-2018;
4. User Behavior for Radical Knowledge Transfer in the Ecosystem (in Latvian: Jauni lietotāju uzvedības interpretācijas algoritmi radikālai zināšanu pārneses uzlabošanai eEkosistēmā - JAUZI)” (Agreement No.2013/0071/2DP/2.1.1.1.0/13/APIA/VIAA/023), expert - 01.10.2013- 31.08.2015;
5. ERDF project - E-technologies in innovative knowledge source and flow systems (in Latvian: E-tehnoloģijas inovatīvās zināšanu avotu un plūsmu sistēmās (ETM)), (2DP/2.1.1.1.0/10/APIA/VIAA/150, RTU ID1534), work package manager, - 01.05.2012 – 30.05.2013;
6. ERDF supported Latvian-Lithuanian Cross-border program project LatLit - Synergetic approach with eLearning, TV and mobile technologies to promote new business developments (in Latvian: Sinerģētiska pieeja jaunu biznesu veicināšanai izmantojot e-studiju, televīziju un mobilo tehnoloģiju iespējas (eBig3), course developer - 01.01.2011. – 31.12.2013;
7. ESF project “Continuing Education of General Education Teachers" (in Latvian: Vispārējās izglītības pedagogu tālākizglītība) (Agreement No. Nr.2010/0062/1DP/1.2.1.2.3/09/IPIA/VIAA/003), course implementation consultant, 07.2012 - 2014.

Involvement of **Aleksandrs Gorbunovs** in research projects:

Management of scientific research projects:

1. National Research Program - Innovative Solutions in Social Telerehabilitation in the Context of Inclusive Education in Latvian Schools” “Development, approbation and implementation of new prototypes, innovative methodologies (approaches, methods, techniques, techniques) in social rehabilitation for the provision of new services” (INOSOCTEREHI), project No.2, RTU ID 1868), project manager – 11.2014-30.06.2018.

Participation in research projects:

2. ERDF project “Technological learning e-ecosystem with random interactions -

TELECI", work package (WP) manager – 03.2017.-07.2018;

3. ERDF Project - New Algorithms for Interpreting User Behavior for Radical Knowledge Transfer in the Ecosystem (in Latvian: Jauni lietotāju uzvedības interpretācijas algoritmi radikālai zināšanu pārneses uzlabošanai eEkosistēmā - JAUZI)", WP manager – 08.2014-08.2015;
4. ERDF project - E-technologies in innovative knowledge source and flow systems (in Latvian: E-tehnoloģijas inovatīvās zināšanu avotu un plūsmu sistēmās (ETM)), researcher – 12.2010-05.2013;
5. ERDF supported Latvian-Lithuanian Cross-border program project LatLit - Synergetic approach with eLearning, TV and mobile technologies to promote new business developments (in Latvian: Sinerģētiska pieeja jaunu biznesu veicināšanai izmantojot e-studiju, televīziju un mobilo tehnoloģiju iespējas (eBig3), researcher, course developer – 04.2011-08.2013.

Postdoctoral research activities:

6. Postdoctoral project "Eye tracking system applications and utilization of gaze data in students behaviour trajectory model development" - Research activities have been supported by the European Regional Development Fund within the Activity 1.1.1.2 "Post-doctoral Research Aid" of the Specific Aid Objective 1.1.1 "To increase the research and innovative capacity of scientific institutions of Latvia and the ability to attract external financing, investing in human resources and infrastructure" of the Operational Programme "Growth and Employment" (Nr.1.1.1.2/VIAA/1/16/042) – 08.2018.-07.2022.

Involvement **of Ieva Vītolina** in research projects:

1. The 7th Framework Program, ERA-NET project - FuturICT 2.0 - Large-scale experiments and simulations of the second generation of future ICT (in Latvian: Plaša mēroga eksperimenti un simulācijas otrās paaudzes nākotnes IKT), expert – 01.01.2017-2018;
2. ERDF project "Technological learning e-ecosystem with random interactions - TELECI", work package (WP) manager - 03.2017-2018;
3. ERDF Project - New Algorithms for Interpreting User Behavior for Radical Knowledge Transfer in the Ecosystem (in Latvian: Jauni lietotāju uzvedības interpretācijas algoritmi radikālai zināšanu pārneses uzlabošanai eEkosistēmā - JAUZI)", WP manager –01.10.2013- 31.08.2015;
4. ERDF project - E-technologies in innovative knowledge source and flow systems (in Latvian: E-tehnoloģijas inovatīvās zināšanu avotu un plūsmu sistēmās (ETM)), WP manager, 01.05.2012 – 30.05.2013;
5. ERDF supported Latvian-Lithuanian Cross-border program project LatLit - Synergetic approach with eLearning, TV and mobile technologies to promote new business developments (in Latvian: Sinerģētiska pieeja jaunu biznesu veicināšanai izmantojot e-studiju, televīziju un mobilo tehnoloģiju iespējas (eBig3), course developer - 01.01.2011 – 31.12.2013;
6. ESF project "Continuing Education of General Education Teachers" (in Latvian: Vispārējās izglītības pedagogu tālākizglītība) (Agreement No. Nr.2010/0062/1DP/1.2.1.2.3/09/IPIA/VIAA/003), course implementation consultant - 07.2012 - 2014.

Involvement of **Sarma Cakula** in research projects:

1. EU FP Horizon2020, project “Adaptive microclimate management in agriculture (in Latvian: “Adaptīva mikroklimata pārvaldība lauksaimniecībā” No. 818187, expert – from 2020;
2. Project “Europe's next generation of small towns” (in Latvian: Eiropas nākamās paaudzes mazās pilsētas), No. UIA03-250, expert – from 2019;
3. National research program “To reduce the effects of Covid-19” (in Latvian: Covid-19 seku mazināšanai), project “Promising technologies for sustainable and secure services” (in Latvian: Perspektīvās tehnoloģijas noturīgiem un drošiem servisiem" (ARTSS), expert, 2021;
4. ERDF project “Technological learning e-ecosystem with random interactions - TELECI”, expert - 2017-2020;
5. Regional research project 2015. Development of a prototype of the Lifelong Learning Development Guidelines for 2016-2020 in Vidzeme region", AL-2015/97 (in Latvian: Mūžizglītības atttstības pamatnostādņu 2016.-2020.gadam Vidzemes reģionā un tehnoloģiskā risinājuma prototipa izstrāde"), expert – 2015;
6. ERDF project, FutureSim “Study methodology for the future knowledge society” (in Latvian: „Studiju metodoloģija nākotnes zināšanu sabiedrībai), No. DP/2.1.1.2/14/APIA/VIA/001, expert – 2015;
7. ERDF Project - New Algorithms for Interpreting User Behavior for Radical Knowledge Transfer in the Ecosystem (in Latvian: Jauni lietotāju uzvedības interpretācijas algoritmi radikālai zināšanu pārneses uzlabošanai eEkosistēmā - JAUZI)”, expert – 2015;
8. EU Framework Programme for Research and Innovation Horizon 2020; COST project “European cooperation in Science and Technology” activity IS1101; Climate change and migration: knowledge, law and policy, and theory”, expert - 2012-2015;
9. ERDF project - E-technologies in innovative knowledge source and flow systems (in Latvian: E-tehnoloģijas inovatīvās zināšanu avotu un plūsmu sistēmās (ETM)), expert – 2012-2013.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The co-operation of the teaching staff is actively carried out at several levels, using different types of co-operation accordingly.

Study courses, study materials, study program, development strategy and sustainability plan are constantly updated, supplemented and improved. Also, new study courses are created or included, taking into account the development trends in the industry. At the time of submitting the self-assessment, there are 13 students. In 2022, 8 main lecturers were involved in the doctoral study process: 3 professors, 3 assoc. professors, 2 leading researchers. The average age of the staff is 60,3 years.

Joint activities are being implemented, in which teachers become more familiar with the content and methods of peer-led courses in order to avoid duplication of content and to implement transdisciplinary cooperation during the course.

An important form of cooperation between the teaching staff of the program is the preparation and implementation of joint international and national projects. In recent years, jointly RTU, LiepU, LU, RTA, and ViA implemented the LZP (Latvian Council of Science) Covid program project ARTSS, within the framework of which extensive research and testing of knowledge perception monitoring technology was performed.

As a result of successful cooperation between RTU, LiepU and ViA, the HorizonEurope project "TED4LAT Twinning in Environmental Data and Dynamical Systems Modelling for Latvia" was jointly prepared. The project has been praised by the European Commission and has been proposed for funding. Within the framework of the project, the implementers of the doctoral program and doctoral students will learn modern dynamic modelling methods.

The implementers of the program together with the Strategic Partner Coursera have prepared a new project application EduAim, which will enable the program to become more closely involved in the international communication.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	REDE0_DoktPr_LV_ENG_Diplparaugi.zip	REDE0_DoktPr_LV_ENG_Diplparaugi.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_EDE0(51482)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_EDE0(51482)_AIP_atzinums250stud_E-stud_tehnolog_parvald.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_RTUkods(IzglKlasifKods)_StatistikaparStud_LV_StatisticsonStudents_ENG2.docx	P05_3.1.4_RTUkods(IzglKlasifKods)_StatistikaparStud_LV_StatisticsonStudents_ENG2.docx
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard		
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	!P08_3.2.1_RTUkods(IzglKlasifKods)_Kartejums_lv_Mapping_eng.pdf	!P08_3.2.1_RTUkods(IzglKlasifKods)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_EDE0(51482)_Plans_lv_Plan_eng.pdf	P09_3.2.1_EDE0(51482)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	P10_EDE0(51482)__StudyCourse Description_EN.zip	P10_EDE0(51482)__StudijuKursu apraksts_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)	EDE0(51482)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip	EDE0(51482)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Smart Computer Technologies (43526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Smart Computer Technologies*
Education classification code	*43526*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Dmitrijs*
Surname of the study programme director	*Bļizņuks*
E-mail of the study programme director	*Dmitrijs.Bliznuks@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*26707961*
Goal of the study programme	*The study program aims to prepare qualified specialists with higher education in computer vision, computer control and computer networks who can create and maintain smart computer technologies solutions for solving various automation and visualization problems.*
Tasks of the study programme	*- Provide comprehensive engineering education and in-depth knowledge of automation and computer technology. - To prepare students for successful professional careers in manufacturing, business and government institutions. - To develop students' individual abilities and provide a stimulating learning environment. - Strengthen the students' desire to constantly improve their knowledge and skills. - To promote the latest scientific and technical knowledge in studies and co-operation with companies. - Develop critical and systems thinking skills and collaborative skills. - To explain and promote the automation and computer technologies in the society.*

Results of the study programme	*Upon completion of the study program, the graduate: - can use the principles of engineering in the field of smart computer technologies methods in computer graphics, computer vision, computer control and computer network technology; - be able to explain the theoretical foundations of smart computer technologies, including the essence of algorithmization, data structures, discrete mathematics, systems theory and computer architecture; - be able to use smart computer technologies in the development of computer systems for enterprises and organizations, including computer networking, computer graphics, computer vision, computer control hardware and software development; - can plan and ensure the operation of the company's intelligent system; - can develop and analyze models of complex systems; - can structure and analyze large amounts of quantitative data; - can integrate separate systems and develop automation and visualization solutions; - can communicate with customers about smart computer technologies tasks and solve them using smart computer technologies; - can carry out research in the field of intelligent computer technologies.*
Final examination upon the completion of the study programme	*Final / state examinations include development and defense of a Bachelor Paper in the field of information technology, the tests in main theoretical and specialized training subjects.*

Study programme forms

Full time studies - 3 years - latvian

Study type and form	*Full time studies*
Duration in full years	*3*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*120*
Admission requirements (in English)	*General or vocational secondary education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor Degree of Engineering Science in Smart Computer Technologies*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The study programme with the initial title “Automation and Computer Engineering” has been developed on the basis of the principles of electronics and computer control of the 20th century, which are mostly no longer topical. The program was initially implemented by four departments: Image Processing and Computer Graphics, Computer Control Systems, Computer Engineering and Networks, Control Technology, where two of the departments dealt with automatic control and regulation, which in turn contributed to the title of the program.

During the reporting period, the institute implementing the program has been reorganised, and currently, the study programme is implemented at the Institute of Smart Computer Technologies and the program name has been changed to “Smart Computer Technologies” which allows logically connecting the program and the institute, as well as the title better represents the updated study program.

The Institute of Smart Computer Technologies now consists of two departments covering two major fields: Computer Graphics and Computer Vision, Computer Control and Computer Networks. The Bachelor’s study programme has been updated according to the fields and currently, the study programme educates and trains qualified specialists who are able to handle smart technologies and understand computer graphics, image processing, scene analysis, computer vision, computer network and system architecture, software and hardware design, sensor systems, embedded systems, robot control technologies and SCADA systems.

The study programme is implemented in the form of full-time studies in the Latvian language. During the reporting period, changes have been made by introducing new study courses, for example, “Embedded Systems”, “Internet of Things Technologies”, “Graphics in Smart Technologies”, “Fundamentals of Security in Computer Technologies”, “Interactive Computer Graphics” and others. Improving existing study courses, changing the staff due to ageing, and attracting new specialists. The content of the study courses is regularly reviewed and supplemented, based on the students’ surveys and recommendations, to ensure that the courses correspond to the current situation in the industry.

In 2021, the process of developing Bachelor Papers has been unified throughout the Faculty of Computer Science and Information Technology (FCSIT).

Amendments in the program parameters are related to changes in the study programme classification codes according to Latvian Republic Cabinet Regulations No. 322 of 13 June 2017. During the previous accreditation period, the education classification code of the study programme was 43523, which was changed to 43526 - other engineering sciences, and the degree was changed to Bachelor of Engineering in Smart Computer Technologies.

In accordance with Cabinet Regulations, No. 240 of 13 May 2014, “Regulations on the State Academic Education Standard”, the volume of the program was changed from 122 CP in 2013 to

120 CP in 2018.

Due to the growing demand for IT specialists in Latvia, the study programme “Smart Computer Technologies” (previously “Automation and Computer Engineering”) is topical. It is implemented in Riga, as well as in Daugavpils, where students are offered the opportunity to study for two years and then continue their studies in Riga.

The study programme includes various basic courses in engineering, such as mathematics, discrete mathematics and physics, as well as courses in the field of IT that are similar to the first two courses of other institutes, such as algorithmisation and programming of solutions, discrete structures in computer science, operating systems, artificial intelligence, computer networks, and computer architecture, etc. In the third year of study, students are offered specialized study courses that relate to one of the fields, such as the fundamentals of computer technology security, robot control systems, 3D graphics modelling and animation, etc.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The volume of the study programme “Smart Computer Technologies” is 120 CP and the duration of studies is 3 years. It has been developed in accordance with Cabinet Regulations No. 240 “Regulations on the State Academic Education Standard”. The duration and volume of the program allow for new specialists to cover the skills required and to start working in the profession faster, which is especially important considering the demand for IT specialists in the Latvian IT sector.

The study programme corresponds to the study field “Information Technology, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science” because the content of the study programme focuses on computer graphics and computer vision, computer control and computer networks and includes knowledge and skills corresponding to information technology, computer science and computer control.

The title of the study programme “Smart Computer Technologies” covers the fields related to smart computer technologies. Smart computer technologies assume that the graduate will be able to apply acquired knowledge in computer science, information technology, computer technology, and computer management. The focus of the program is on computer graphics, image processing, scene analysis, computer vision, robot control, SCADA systems, including embedded systems, computer networks, and sensor technologies. The graduate will be able to explain the theoretical foundations of intelligent computing technologies, including the nature of algorithmization, data structures, discrete mathematics, systems theory and computer architecture.

The aim of the study programme is to educate and train qualified specialists with higher education in the field of computer vision, computer control, and computer networks, who can create and maintain smart computer technology solutions for solving various automation and visualization problems.

Specialists will be able to structure and analyse large amounts of quantitative data and use intelligent computer technologies in the development of computer systems of companies and organizations, including the creation of computer networks, computer graphics, computer vision, computer control hardware and software development. Graduates of the study program will have in-depth knowledge in mathematics, physics, discrete data structures, artificial intelligence, computer control basics, computer networks and computer graphics, algorithmization.

The classification code of the study programme 43526 – Engineering sciences and technologies (other engineering sciences) – has been chosen because the aim and content of the program are related to smart computer technologies, which implies the development of engineering solutions for specific problems of society. Upon completion of the study program, a Bachelor’s degree in Smart Computer Technologies is awarded.

General or professional secondary education is required to commence studies in the academic Bachelor’s study program.

It can be concluded that the title of the program, classification, code of the program, and the degree to be obtained are mutually consistent and correspond to the study field.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Citing the National Development Plan of Latvia for 2021-2027, it can be concluded that “Human capital, its availability, qualifications and its compliance with the demand of the labour market, high-quality and inclusive jobs are elements of the chain towards higher productivity and economic growth”. Increased productivity enables companies to earn more and invest more, and to create more jobs in the long run, while workers need to benefit from higher job quality—higher wages, safer jobs, equal rights, adequate social protection, health care, especially in the regions of Latvia.

Digital transformation is the key to productivity, economic growth, the well-being of the individual and society. The knowledge society not only understands, adapts, and makes full use of the new reality transformed through digitalization, but is a motivated, skilled, and intelligent driver of a comprehensive digital transformation of Latvia. The higher education system supports the development of an environment of scientific excellence. This takes the form of comprehensive international and cross-sectoral cooperation, active innovation, and funding for scientific progress. Scientific research in Latvia strengthens the sustainability of society, economic capacity, and the development of national identity. International cooperation and involvement in European science is a precondition for future growth, access to new knowledge and resources, and the flourishing of the creative industries.

Productivity is boosted by new knowledge and technologies, ample educational opportunities and support of innovation, investment in human capital, and a supportive institutional environment that translates knowledge into internationally competitive products and services with higher added value, creating an export-oriented modern national economy, which is available here https://www.em.gov.lv/lv/media/598/download (Only in Latvian)

Both in the global and domestic markets, employers will increasingly demand specialists with technological knowledge. There is already a shortage of engineering specialists in Latvia, but in the future, it will become an increasing problem for many companies.

"The latest mid- and long-term labour market forecasts of the Ministry of Economy published in

2020 show that there will be a high demand for engineering, natural sciences and information technology specialists in the labour market in the coming years. In recent years, young people have heard the call of employers to study engineering, natural sciences and high technologies, as interest in studying at RTU has increased" quoted from https://www.rtu.lv/lv/universitate/masu-medijiem/zinas/atvert/latvijas-iedzivotaji-augstskolu-izvelas-pec-studiju-kvalitates-un-nakotnes-iespejam-darba-tirgu (Only in Latvian)

Graduates of engineering sciences, computer network engineers, computer graphics and image processing specialists, industrial automation specialists, robotics specialists are in wide demand on the labour market, as can be seen from the advertisements.

Graduates of the study program work in such large companies as "Accenture", "ZZ Dats", "Olimp", "ABB Latvija", "Apply IT", "Evolution Gaming", "Mobilly", "Peruza", "Tieto".

Graduates work as IT consultants, application software developers, programmers, computer network administrators, system administrators, testers and automation engineers, etc.

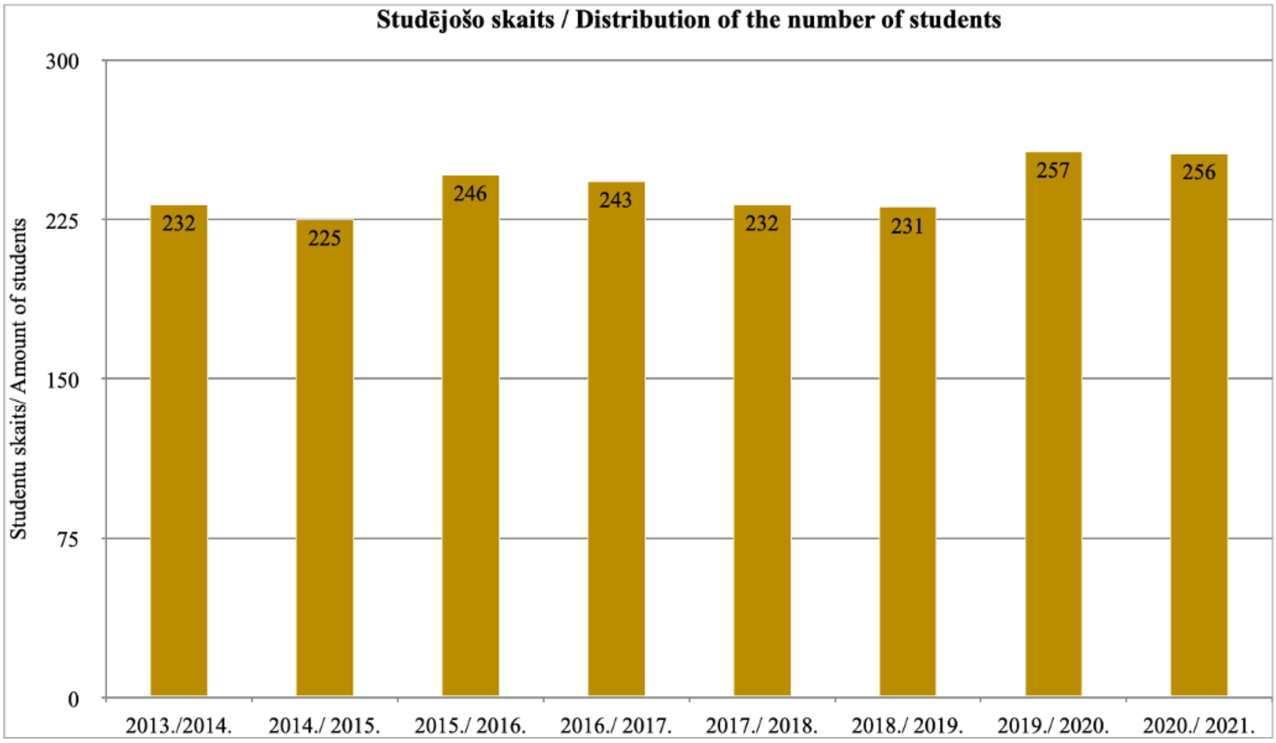
According to statistics on higher education, more than 88% of graduates of the Bachelor’s study programme “Smart Computer Technologies” are employed. A high proportion of employed students is among the graduates of science and mathematics, statistics, and IT thematic groups. The average income of 2017 graduates in the 2018 tax year (one year after graduation) was 14,677 EUR, which was approximately 22% higher than the average salary in the country in 2018; for comparison: the income of 2018 graduates in 2019 tax year (one year after graduation) was 15,968 EUR (which was approximately 24% higher than the average salary in the country in 2019). It means that in the first year after graduation the income of graduates is on average 23% higher than the average salary in the country. This is concluded from the results of the monitoring of the graduates of these two years.

In the second year after graduation, the income of 2017 graduates in the tax year 2019 was already 17,662 EUR, i.e., approximately 37% higher than the average income in the country in the respective tax year.

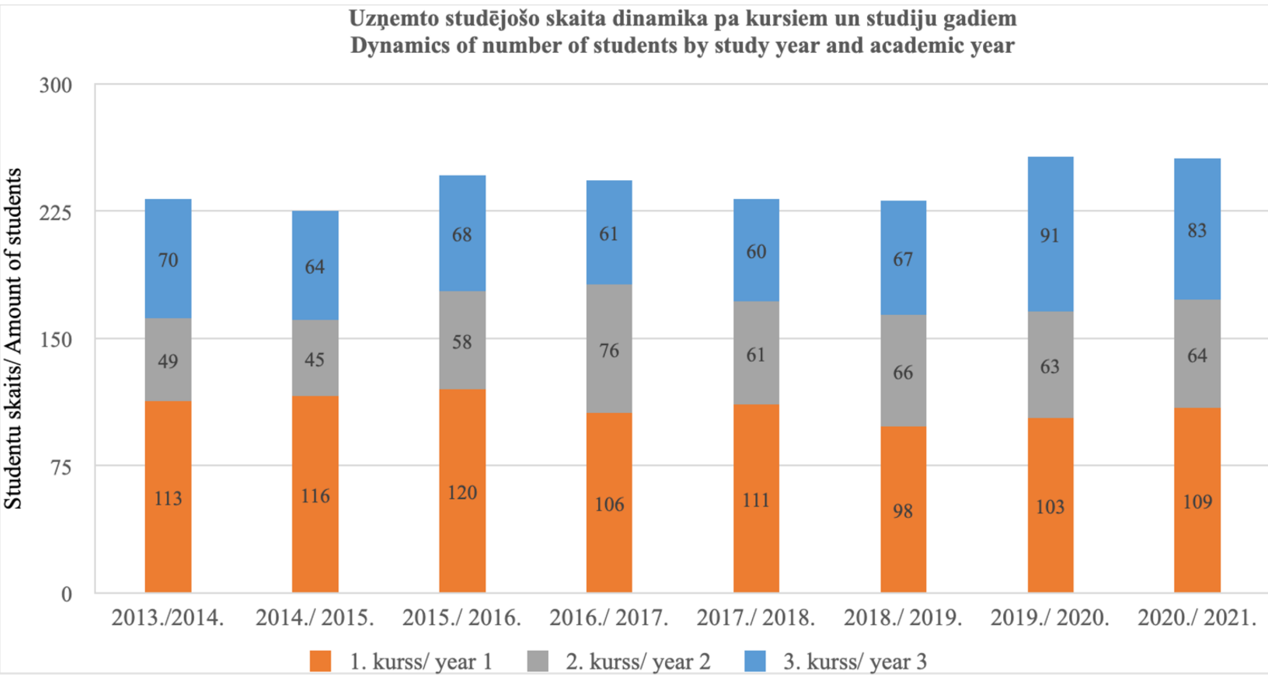
3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

During the reporting period, the academic Bachelor’s study programme “Smart Computer Technologies” has been implemented in-person, full-time, and in the Latvian language.

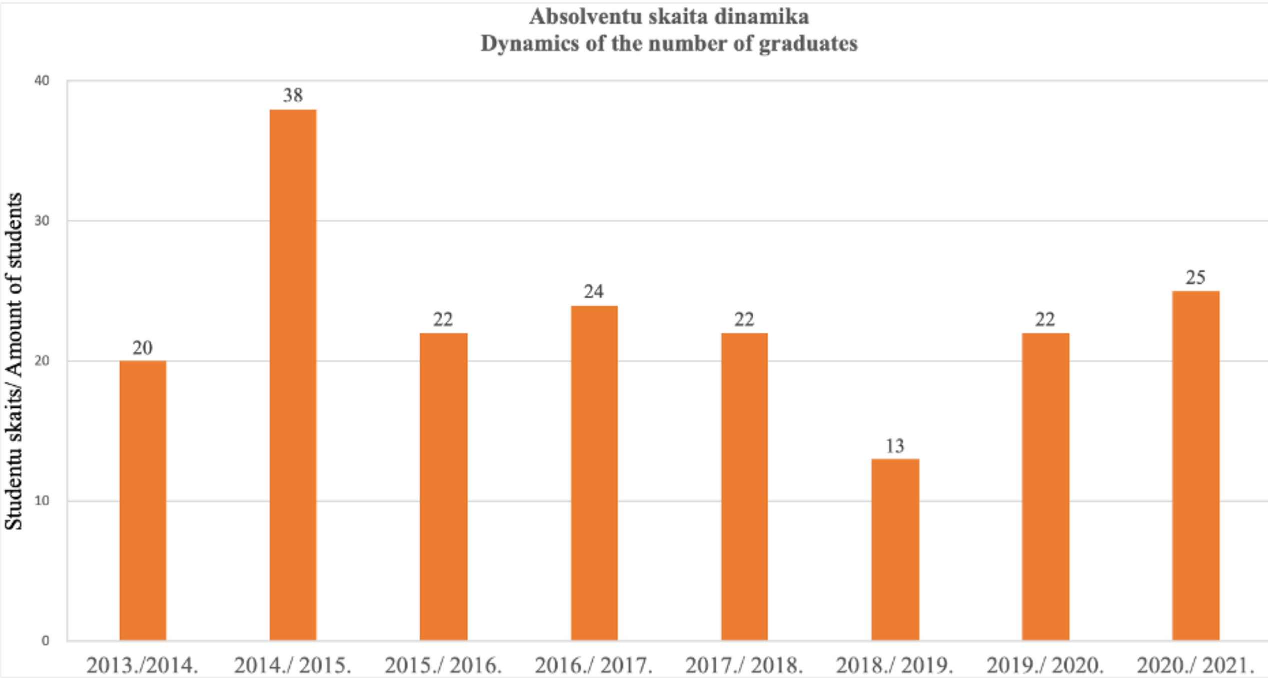
The average number of students during the reporting period has been 240. The total number of students has ranged from 231 to 257. The largest number of students per year (257 students) was observed in the academic year 2019/2020. The lowest number of students was 225 in the academic year 2014/2015. In the last two years, the number of students increased, for example, in the academic year 2013/2014 the number of students was 232, but in the academic year 2020/2021 it reached 256. In general, the distribution of the number of students for the reference period was even, with slightly positive dynamics over the last two years. The number of students increased slightly during the COVID pandemic, which might be due to fewer opportunities in the labour market. As a result, students had time to acquire the study courses more diligently.



Observing the data on the number of enrolled students, it can be concluded that the academic year 2015/2016 had the largest enrolment, preceded by the academic year 2014/2015. Comparing the data in the reporting period by study year, it can be concluded that in academic year 2014/2015 the number of second-year students was the lowest (only 45 students). Also, academic year 2014/2015 showed the highest number of dropouts among first-year students due to academic failure. This affected both the total number of students and the learning process very significantly. In 2015, another programming language was taught to the first-year students. These changes are very well reflected in the graph, with a decrease in the number of first-year students due to dropping out. It can be seen that during the COVID-19 pandemic, the number of third-year students increased rapidly, which also affected the increase in the number of graduates. This may be due to the fact that students spent much more time studying and were motivated to obtain a Bachelor degree in order to find a better job or to continue their studies at the Master level.



The average number of graduates of the study programme in the reporting period was 23. The largest number of graduates was 32 in academic year 2014/2015, which was related to the basic quality requirements for the Bachelor Paper. However, the requirements were reviewed in academic year 2015/2016 to achieve the high quality of the Bachelor Paper, being one of the main goals of the study program. In general, the number of graduates during the reporting period remained at the same level. The significant drop in the number of graduates (only 13 people) was observed in academic year 2018/2019, which could be affected by the administrative reorganization of the institute. However, over the last two years the positive dynamics was observed, which could be deduced from the growing number of graduates. Also, the requirements for the development of the Bachelor Paper were increased with a plan offered to students on how to gradually develop and successfully deliver a public presentation of the Bachelor Paper.



3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of

the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The aim of the Bachelor study programme “Smart Computer Technologies” is to educate and train qualified specialists with higher education in the field of computer graphics, computer vision, computer control and computer networks, who are able to select, create, integrate, use, implement and maintain user-friendly intelligent computer solutions for companies and organizations.

The volume of the Bachelor study programme “Smart Computer Technologies” is 120 CP, and the duration of studies is 3 years. In the first and second years of study, the academic bachelor study programme is the same for all students of the FCSIT, but in the third year, students study within the specific programs. Upon completion of the study program, the student obtains a Bachelor’s degree in the field of Smart Computer Technologies.

The main task of the Bachelor’s study programme is to provide students with a scientific basis for professional activity, develop the skills of scientific analysis and the ability to solve problems independently, as well as to educate and train students for further research studies.

The learning outcomes of the study program: Upon completion of the study program, the graduate is able:

- to use engineering principles of automation and intelligent computer techniques in computer graphics, computer vision, computer control and network technology.

- to explain the theoretical foundations of smart computer technologies, including the nature of algorithmisation, data structures, discrete mathematics, systems theory, and computer architecture.

- to use smart computer technology in the development of computer systems for companies and organizations, including computer network design, computer graphics, computer control hardware and software development.

- to plan and ensure the functioning of the company’s intelligent systems.

- to design and analyse complex system models.

- to structure and analyse large amounts of quantitative data.

- to integrate separate systems and develop automation and visualization solutions.

- to communicate with the customers that are commissioning smart computer technology tasks and implementing them using smart computer engineering.

- Able to implement research in the field of computer engineering

The study programme consists of compulsory study courses, or Part A (82 CP), compulsory elective study courses, or Part B (24 CP), free elective study courses, or Part C (4 CP), Bachelor Paper (10 CP). The compulsory part of the Bachelor study programme includes the guidelines, principles, structure and methodology of the respective branch and sub-branches of science to be acquired:

- fundamentals of computer architecture, fundamentals of computer control and computer networks;
- fundamentals of computer graphics and image processing;
- development of innovative products and entrepreneurship;

- fundamentals of computer network design;
- fundamentals of programming;
- fundamentals of artificial intelligence;
- fundamentals of data structure;
- operating systems;
- fundamentals of industrial system SCADA;
- database management systems.

The program addresses the historical and contemporary development trends of the respective branch and sub-branches of science, as well as covers the topical issues from the interdisciplinary perspective, stimulates the acquisition of basic knowledge in languages, economics and sociology to promote students' intellectual activity, and develops practical skills in solving engineering and research tasks.

The implementation of the program "Smart Computer Technologies" is ensured by the Institute of Smart Computer Technology with its departments:

- Department of Computer Graphics and Computer Vision;
- Department of Computer Control and Computer Networks.

The content of study courses is updated based on RTU regulations, available at https://www.rtu.lv/lv/studijas/bakalaura-limena-studijas/studiju-reglaments (Only in Latvian). Taking into account the rapid changes in the IT industry and the development of technologies, study courses are regularly updated, as well as the content of the study program is changed, thus ensuring the compliance of the study program with the development trends of the IT field and the needs of the labour market. Study courses are being introduced to enable the students to become highly qualified and competitive specialists in the labour market, for example, "Embedded Systems", "Internet of Things Technologies", "Graphics in Smart Technologies", "Fundamentals of Security in Computer Technologies", "Interactive Computer Graphics" and others.

During studies, students are offered group work from the first year, when they are introduced to the study process, in order to better prepare students for work in a project-oriented environment of the IT industry, forcing students to work in teams, solving complex problems related to software development. It develops teamwork skills and creative thinking.

- Considering the fact that an approach rooted in deep neural networks has become dominant in the field of machine learning over the past 10 years, study courses in the field of artificial intelligence have been added to both the mandatory and optional parts of the program.
- With the development of new data storage and data retrieval technologies, the study course on database technologies has been updated to include the latest industry trends in terms of both technology and logical models.

Within practical assignments and graduation paper, students are offered themes that are related to the current industry issues. Students have the opportunity to conduct research and analyse tasks of various complexity related to image processing, computer vision, embedded systems, robot control technologies or sensor networks. Students are also offered various opportunities to participate in research projects and gain experience in research work.

The goals, tasks and achievable results of all study courses of the study program lead to the achievement of the study results and overall goal of the study program, as well as the fulfilment of tasks. Regular analysis and updating of study courses avoid overlapping and duplication of study courses. Looking at the study map given in Appendix P8, the first two objectives of the study program are most fulfilled: "Able to use the principles of engineering sciences, methods of smart computer technologies in computer graphics, computer vision, computer control and computer network technology", as well as "Able to explain the theoretical foundations of smart computer technologies, including the nature of algorithmization, data structures, discrete mathematics, systems theory and computer architecture.” The achievement of the goal of each study program is ensured by the achievable results of at least 10 study courses, which are completely sufficient. The lowest number of links between the results of study courses is with the student's ability to carry out research in the field of smart computer technologies - the student's ability to carry out research depends on the ability to study various scientific articles, evaluate and choose solutions for solving complex tasks, which are not always offered in study courses, but only for some. The study map also reflects the fact that the objectives of the study programs promote the ability to develop and analyse models of complex systems, as well as to structure and analyse large amounts of quantitative data. This is indicated by the results of at least 20 study course objectives, which are fully sufficient.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study programme is implemented in the mode of full-time in person studies in Latvian, complying with the requirements stipulated by regulations, and basic principles of organization of studies at RTU and fulfilling the requirements of the study courses. Descriptions of the study courses of the program specify the corresponding body of knowledge, skills and competences, and their evaluation system, define learning outcomes to receive credit points. The assessment procedure for students’ knowledge, skills and competences is specified in the decision of RTU Senate of 27 May, 2017 “On the Regulation on the Assessment of Learning Outcomes” that is in compliance with the basic principles and procedure of education assessment defined by the Latvian Republic Cabinet regulations in the relevant education cycle.

Evaluation of the study results achieved in the study course can take place in intermediate tests, in the exam, in the defence of the study project.

The evaluation of the learning outcomes achieved within the study course can be implemented in the form of the interim tests, exams, public presentation of the study project and the internship report.

Summative assessment is used in the assessment of learning outcomes when the final grade consists of several components. Full-time studies imply the acquisition of 40 CP per academic year and the workload of 40 hours of studying per study week, which makes 1 CP. Within the Bachelor's studies, 50% of the workload is taken by contact hours and 50% is individual work (self-education).

Filed-specific study courses, such as "Discrete Structures of Computer Science" (3 CP) or "Fundamentals of Computer Management" (3 CP), "Object-Oriented Programming" (3 CP), "Database Management Systems" (4 CP), "Innovative Product Development and Entrepreneurship" (4 CP), allow providing theoretical knowledge, as well as devoting sufficient time to the acquisition of practical skills and fulfilment of independent assignments. There is also the study course "Algorithmisation and Programming of Solutions" (6 CP). The course allows 1st-year students to acquire the necessary basic knowledge of programming. The course combining both the theoretical and practical parts is delivered during 2 semesters.

If the volume of the study course exceeds 2 CP, it must also include practical work, laboratory work or work in groups. Already in the first study year within the course "Introduction to the Study Field" students are given the opportunity to choose an interesting topic and work in a small group, researching different technologies and sharing responsibilities with group members. Other courses, such as "Introduction to Image Processing" or "Interactive Computer Graphics", are organized in a similar way, where students are given the opportunity to complete and publicly present a task in a small group, thus demonstrating their understanding and competence in the material covered.

The Moodle-based RTU interactive e-learning environment operating on the web portal www.ortus.rtu.lv is used in the implementation of the study program. It is regularly used by the study programme students, academic staff and visiting lecturers.

To achieve the study results, hybrid teaching methods are used, which combine verbal teaching methods, explanatory teaching methods, interactive teaching methods, as well as demonstrative teaching methods. Various types of feedback are actively used during lectures, including using modern IT solutions, such as student survey tools (for example https://quizizz.com/), which also serve to implement emotional stimulation and recognition methods.

On the portal, students have access to all relevant information throughout their studies. It hosts relevant study courses (abstracts, requirements for successful acquisition of the study course, lecture plans, lecture notes and practical exercise, mandatory literature and other information materials), information on a student's achievements and acquired study courses, the latest news, library information, access to learning and scientific literature and databases, e-mail, etc. The academic staff place different tests and tasks in the e-learning environment for self-control of knowledge, also, the system gives an opportunity to build various interim and module tests. The framework of the portal allows communication with all the academic staff members, but in the framework of current courses - also with the fellow students. The portal hosts discussion forums, regular surveys on the curriculum, quality of the study courses and academic staff that will deliver a study course, presentations, also other audio/video and technical aids.

A New edition of the "Regulation on the Assessment of Learning Outcomes" was approved by RTU Senate on 29 May, 2017, it is also included in the RTU Regulation of Studies. According to the Regulation, every study course incorporates interim tests (tests, module tests, individual works, etc.), to ensure systematic control of the acquired knowledge. The order also specifies the procedure for academic progress testing, the rules for exam and test procedures, the conditions and procedure for clearance of academic debts, responsibilities of the academic staff in the assessment of outcomes, rights and responsibilities of the students during tests, as well as the procedure for submission and consideration of appeals. Interim test results and assessment grades are published in the ORTUS system under the heading of a corresponding study course. Mistakes are analysed and students are informed about them. Analysis of mistakes allows students to better understand unclear themes and eliminates the lack of knowledge or misunderstanding of certain aspects, which increases the motivation of students to achieve yet better learning outcomes. In the e-learning environment, students can constantly monitor their progress in study course acquisition. The academic staff use analytical opportunities of e-learning to supervise students' activity and assess effectiveness of available materials. In case of online studies, the analytic opportunities of "MS Teams" are used to control student activities during online studies. The number of interactive activities grows during online studies, where students work in a collaborative environment submitting work results and replying to questions. For these purposes "MS Forms" opportunities also are widely used, whereupon student answers at once can be summarized analytically.

RTU considers all aspects of student-centered education in order to increase students' motivation and improve the quality of their studies.

1. Student involvement in the study process and content development

There is a semesterly survey in which students give feedback on the study course as a whole. Students also have the opportunity to contact the head of study program or RTU Study Department at any time, where there is a possibility to submit a complaint anonymously to inform about problems that have arisen in the study process.

2. Learning outcomes

In the study courses, academic staff clearly define the learning outcomes and their relevance to software development and other IT processes, and link the outcomes to the study program learning outcomes and the study course volume in terms of credit points. Academic staff consider the diversity of students by offering assignments at different levels of difficulty and by providing learning materials for both the core and the advanced content of the course. Students are also offered a wide variety of learning materials (document, presentation, video recording, interactive learning materials, etc.). Students can propose their own theme for the graduation paper, thus achieving the learning outcomes in a way that interests them.

3. Mobility

Within the ERASMUS+ and other student exchange programs, RTU provides students with the opportunity to study voluntarily at another university abroad for part of the duration of their studies (usually one semester, but other mobility durations are possible), gaining experience of IT education abroad. By meeting guest lecturers in specially organized seminars, the academic staff involved in the implementation of the study program also adopt good practices that the guest lecturers can share. Mobility opportunities also serve to improve the qualifications of academic staff by gaining experience in universities abroad.

4. Social dimension

Students studying in the study programme "Smart Computer technologies" have sufficient flexibility to combine work/family life with their studies. As a positive fact it should be noted that RTU library is available to students 24 hours a day and also at weekends.

5. Teaching and learning methods

The teaching and learning methods described previously are used in the implementation of the study program and are adapted by the academic staff to the specific situation. Students have the opportunity to receive individual consultations from the academic staff involved in the study program, including communication in the e-environment using RTU licences for Zoom and MS Teams platforms, as well as messaging services of the Moodle platform.

6. Learning environment

In 2021, a new FCSIT faculty building was opened on Zunda krastmala 10. Students have access to all the technical equipment needed for modern IT education - computer labs, including virtual computer labs. The new building has quiet working and relaxation areas on each floor. Modern videoconferencing tools such as Zoom and MS Teams licenses for remote lectures and tutorials, as well as other software licenses, including academic ones (e.g., MS Office, and various software development environments and tools) are also available. Classrooms also have the technical equipment to support hybrid learning.

Throughout the implementation of the study program collaboration between librarians and academic staff is ensured, with the aim of improving teaching and learning process. In the first year of studies, students are introduced to the resources and databases available in the library. Following the modern demand, RTU Scientific Library is digitalizing, offering more and more resources in e-format, including the most important databases of scientific articles in the IT field (IEEE, SpringerLink, ACM, ScienceDirect, Wiley, etc.).

7. Academic staff competence development

The academic staff involved in the study program are provided with regular opportunities to develop their methodological and didactical skills. The competence development process of academic staff includes methodological seminars on teaching and learning methods, including innovative teaching methods, as well as RTU Methodological Conference.

SAM 8.2.2 project provided the opportunity to do internships in IT companies, thus mastering the latest approaches and methods used in the industry in order to integrate them into study courses.

8. Extra-curricular activities for students

A wide range of extra-curricular activities are offered to the students of the study program:

- Students are also involved in scientific work and research on the topics relevant in the field, participating in both local and international projects, which gives them the opportunity to participate in international conferences.
- Every student at RTU is offered opportunities to participate in extra-curricular activities (sports teams, dance groups, choirs, etc.) organized by different RTU departments.

In general, it can be stated that the material and methods used within the program correspond to the aims of the study program, as well as provide sufficient diversity for the use of student-centred learning approaches.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

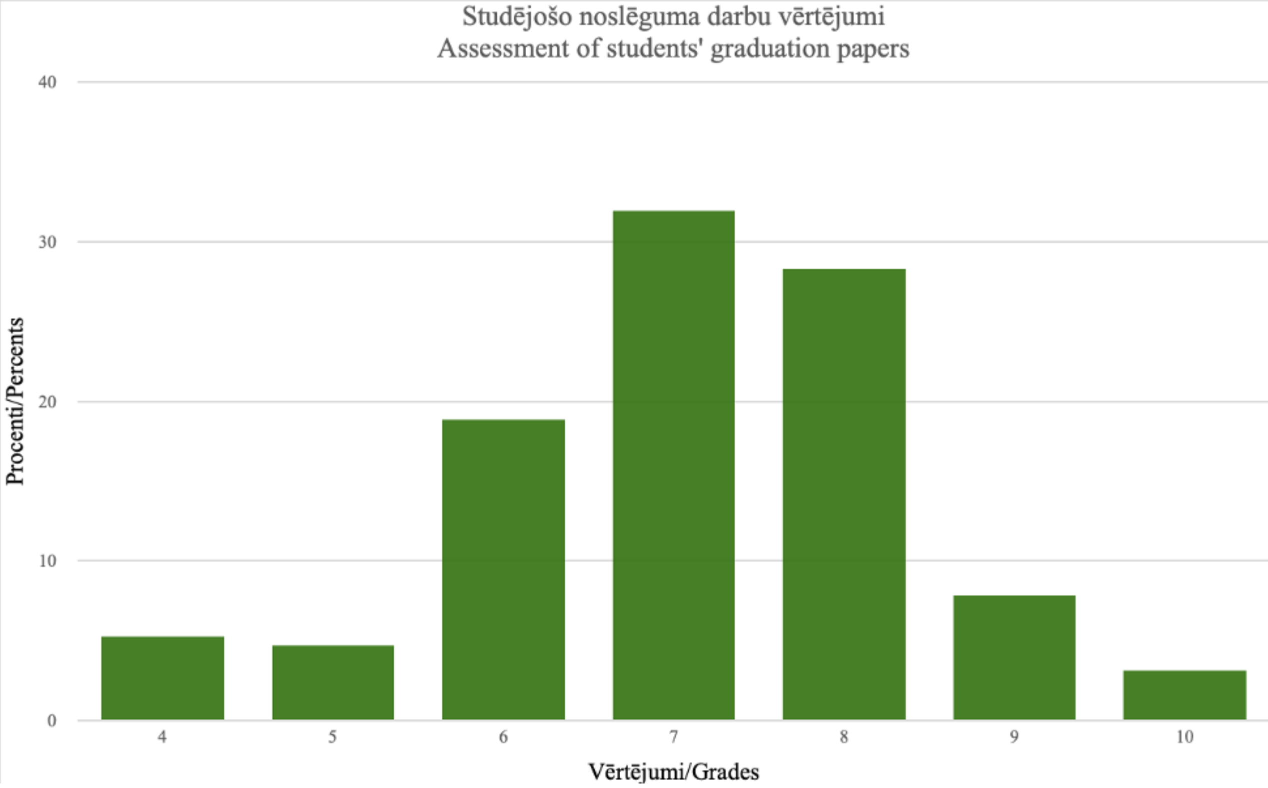
3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

To obtain a Bachelor degree, a student must complete the study programme in full capacity, develop and publicly present the Bachelor Paper in front of the State Examination Committee. Public presentation of the Bachelor Paper takes place in the 3rd year. During the autumn semester, students are offered to choose the field and / or topic of the Bachelor Paper, which is offered by the academic staff of the department. Students can get acquainted with the descriptions of each of the fields, contact potential scientific advisers and specify the topics of the Bachelor Paper. Students can also offer their own themes for the Bachelor Paper, by substantiating the topicality of the research.

The graduation paper is evaluated by the scientific adviser, reviewer and the State Examination Committee. During the reporting period, 191 new specialists have completed the study program, who have fulfilled all the requirements of the study programme and developed the graduation paper.

In the reporting period, the average grade of the Bachelor’s Paper was 7.1. Examining the diagram “Assessment of Students’ Graduation Papers”, it can be concluded that the most common grade is 7 (32%). The next most frequent result is 8, accounting for 28%. It can be seen how much difference there is between the papers, which are evaluated with grade of 8 and 9. The number of such papers is relatively small (8%). The student must conduct compulsory research and include an experimental part on the chosen theme.



In the previous years, students were required to participate in pre-defence, thus reducing the number of graduation papers being evaluated with a grade lower than 5. From the assessment shown in the diagram, it can be concluded that the proportion of graduation papers, which are assessed with a grade of 4 and 5, is about 5%.

During the reporting period, students have been offered the following fields for research:

Computer graphics and virtual reality – the field includes tasks related to interactive 3D graphics, modelling, and animation. The program includes topics related to virtual and augmented reality training processes, and phobia treatment therapies.

Image processing and analysis – the field includes tasks related to the development of graphical editors for both the web and smart devices. The field includes various research tasks related to the analysis and evaluation of image regions.

Pattern recognition and computer vision – the field includes tasks related to the identification, video processing and analysis of biometric data or objects for further tracking or identification of objects.

Multimedia technology – includes tasks related to the processing and further analysis of audio or video signals, or data transmission.

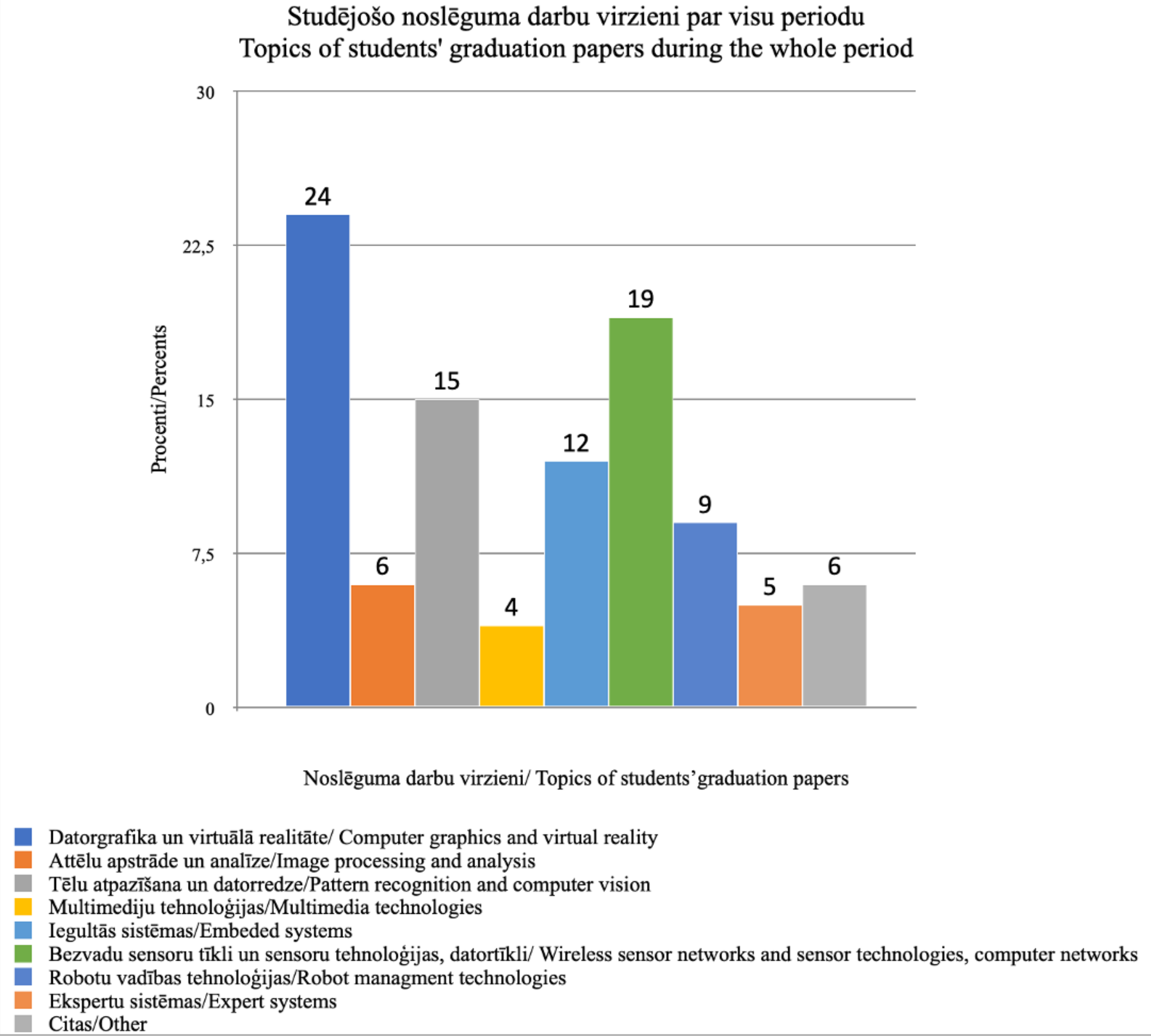
Embedded systems – the area includes tasks related to the determination of changes in the position of moving objects, detection of human presence in the room, the use of active radio markers in area security systems.

Wireless sensor networks and sensor technologies, computer networks – the area includes tasks related to the use of wireless sensor networks for air quality assessment in classrooms, detection of human hand movements and gestures, security in sensor networks, unified data exchange between applications and platforms.

Robot management technologies – the area includes tasks related to the control of an industrial ABB robot, programming of delta robots, development of smart applications for robot control.

Expert systems – the area includes tasks related to the development of applications or software for multi-criteria evaluation methods for various solutions to medical problems.

There were also themes in other fields proposed by other institutes and departments.



Summarizing and reflecting on the chosen areas of the graduation paper, it can be concluded that all themes can be divided into three large groups by departments. 45% of the themes chosen by the graduates belong to the Department of Computer Graphics and Computer Vision, which include computer graphics, image analysis, image recognition and computer vision. The majority of graduates (49%) choose the areas of the Department of Computer Control and Computer Networks, i.e., multimedia technologies, embedded systems, sensor networks, computer networks, robot control systems and expert systems. Other graduates (6%) choose themes proposed by other institutes and departments.

The topics of the graduation papers are suggested, considering the trends in the world and Latvian labor market. Companies (Accenture, Apply, etc.) are also involved in formulating topics. As an example, we can mention topics related to computer vision tasks - tracking objects in a video stream, recognizing a car's license plate, face tracking or recognition. The topics of bachelor's theses are related to several directions, such as industrial computer vision, industrial automation, medicine and health care, education. For example, the segmentation and analysis of medical images, or the application of augmented reality to learning subjects to improve students' knowledge in learning complex topics. An obligatory part of creating a bachelor's thesis is researching the relevance of the topic or problem in the world and in Latvia and adapting the purpose and task of the thesis to current trends in the labor market and research field.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

Riga Technical University study provision corresponds to the study program. It consists of study rooms, laboratory equipment, e-study environment and bibliographic resources. For each study course, the required study provision is indicated.

The studies take place at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at Zunda krastmala 10, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The faculty is located in the same campus as the RTU Scientific Library, providing rooms for group works and quiet reading rooms.

The conference center has a large auditorium with 500 seats, the faculty has 15 auditoriums with 25-200 seats and 12 computer classrooms with 20-25 workplaces each. Students have the opportunity to use their laptops and connect to the RTU wireless network. Auditoriums are equipped with modern audio and visual equipment, which includes a projector, computer, control panel, sound devices, microphones and cameras.

In the study process, software corresponding to pedagogical needs and current trends is used:

- open source software is widely used, including Linux, Docker, Kubernetes, Python, R and others depending on the specifics of the study courses. Programming study courses use the "Eclipse" integrated development environment.
- The use of collaborative resources, including GitHub, Miro, and SharePoint, is encouraged throughout the study process.

For additional convenience of RTU students, academic staff and employees, RTU leases “Microsoft Windows” and “Microsoft Office” software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU-provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail service.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalog of all IT services in the same place.

For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programs (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programs, the study course register (https://info.rtu.lv/rtupub/disc2/list - public part), development of individual study plans, drafting of orders, study courses and training, the input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in the administration of the study process.

To ensure efficient study process, “Moodle” e-learning environment is used, where all required information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-instructor communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc. On ORTUS portal students can see their financial information and make requests for documents (certificates, academic records, copies of the agreement, etc.). The academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

More than 130,000 unique study course websites have been generated in the RTU e-learning environment since 2007. Students can connect and get access to electronic learning aids at any time and place.

Effective classroom resource management and planning of studies is provided by digitalization of premise and time schedules (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or member of the academic staff can see their schedule that indicates places, times, names of lecturers, classroom names and types of classes. To provide users with extra comfort, the system significantly facilitates planning and scheduling of classes, as well as optimizes premise occupancy and use efficiency.

The following resources are used for the implementation of the academic study programme “Smart Computer Technologies”:

- Shared auditoriums for lectures and practical classes. The study programme is implemented at the Ķīpsala Campus, which has both FCSIT rooms and RTU shared premises. The facilities are accessible for persons with disabilities. Available classrooms are described in Part II, Chapter 3, Section 2.3.2: Course resources and provision.
- Computer classes and computer laboratories, given the specifics of the program, are especially important. For each study course, the necessary software is purchased and installed in the computer laboratories, academic licenses are mostly used for specific software. In general, specific computer classes at the Institute of Smart Computer Technologies are available. Windows computer classes are available at the institute. In total, the Institute of Smart Computer Technologies has 5 specially equipped computer laboratories. Much attention is paid to the equipment to provide technical support to FCSIT students during the course for the development of group projects, laboratory work, and research. Laboratories contain special equipment to support such fields of study as

embedded systems, computer networks, programmable logic controllers, robot control technologies, computer graphics, and computer vision.
- FCSIT shared computing center, which provides access to computing resources in the cloud. Virtual computer labs are also available for students to use specific software remotely. To ensure the quality of the study process and scientific work, the following resources are provided at RTU Computing Center:
    - L2, L3 level networking equipment with speed up to 10 gigabits/s is ensured in the study process. The equipment is connected to other university infrastructure equipment to ensure a stable, continuous speed. For scientific research data, computer classrooms are equipped with optical cable network equipment.
    - The provision process includes a physical process on which the virtual servers are running using Hyper-V technology. To secure high server availability and security, Microsoft Hyper-V Failover Cluster technology is used which also increases computing power, load balancing and availability (5 servers with at least 120GB of RAM). In addition to Microsoft Hyper-V server virtualization technologies, VmWare vSphere Essentials virtualization solution is used to maintain faculty infrastructure and training information systems (2 servers with 288GB RAM), as well as CloudStack cloud computing solution for researchers (16 blade-type servers with at least 2TB RAM).
    - In two classes, computers are equipped with high-performance graphics cards (GPU) and 10 gigabit network cards, which are connected in a single network with Mikrotik devices (switches).
    - Interactive classroom equipment is available in computer classrooms to improve the quality of the learning process. Computer classrooms are provided with licensed software, such as: ADONIS, Aimsun Next, Anaconda3, AnyLogic, Arena, Blender, GIMP, GIT, Inkscape, LibreOffice, MATLAB, MS Office, MS SQL Server, MS Visual Studio, MySQL (package), OlapCube, Oracle VM VirtualBox, PuTTy, QGIS, R, RStudio, WireShark.
- Virtualization services, which allow students to gain the computing resources needed to perform various tasks and experiments with appropriate software and infrastructure, including a fixed Internet connection.
- In 2015, the National Research Center for Information, Communication and Signal Processing Technologies was opened at the FCSIT, where students have the opportunity to join the research relevant to basic and applied research in computer systems development, especially, but not limited to, developing their Bachelor Paper.
- RTU Scientific Library.

RTU Scientific Library (SL) is a library of national importance, which has acquired its status as a result of library accreditation. SL provides the RTU study process and research activities with the necessary information, performs library, bibliographic and informational services for RTU students, teaching staff, and employees. SL has 1.3 million printed documents and e-resources in databases corresponding to RTU branches.

In 2016, significant investments were made in the development of the SL infrastructure by building additional premises with an area of 2240 m^2. The total area of SL premises is 6,393 m^2, of which 3,417 m^2 are reader service premises. SL users have 713 work places. SL has created four group rooms and six individual booths, a rarities reading room, and a conference hall.

RTU Scientific Library has a wide range of books and other resources appropriate for the professional Bachelor study programme “Smart Computer Technologies” (description of RTU Scientific Library is given in Part II, Chapter 3, Section 2.3.3.). Upon request of the administration of the study programme 81 new books have been purchased in the period 2013-2021 for the amount of EUR 5523.76.

Part II, Chapter 3, Section 2.3.3 Course resources and provision lists the e-resource collections available in RTU Scientific Library. These collections are of great use in the process of development of graduation papers, independent work, or it can be used in the research purposes. The collection includes the following databases:

ProQuest Ebook Central Academic Complete, Wiley Online Library, SpringerLink e-books, ACM Digital Library, IEEE Xplore Digital Library, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, eBook Academic Collection EBSCOhost, MasterFILE Reference eBook Collection EBSCOhost, MasterFile Premier EBSCOhost, eBook Open Access Collection EBSCOhost, Open Dissertations EBSCOhost.

RTU Scientific Library is open to users from Monday to Saturday. There is a reading room open for 24 hours. At the request of students during the examination period of December 2019 and January 2020, five floors of the Scientific Library with its collection were available to users 24 hours a day.

At RTU premises, students have access to a wireless Internet connection, which provides students with the opportunity to learn additional study materials, participate in various interactive activities during the lesson, for example, surveys.

In both the electronic catalog and the RTU portal, ORTUS library resources can be reserved remotely, and remote access to databases is also provided. Since the introduction of RFID technology, users can use five self-service book issuing-handover machines and hand over books to the handover-sorting machine around the clock. The term of use of books can be extended remotely.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The available resources and facilities meet the conditions for the implementation of the study programme and contribute to the achievement of the learning outcomes. The academic Bachelor study programme “Smart Computer Technologies” is implemented both as a program financed by the basic budget financing received from the Ministry of Education and Science with 90 state budget funded seats and as a tuition fee-based study programme with Latvian as the language of instruction. The data on funding are presented in the table below (see Table 3.1).

Table 3.1

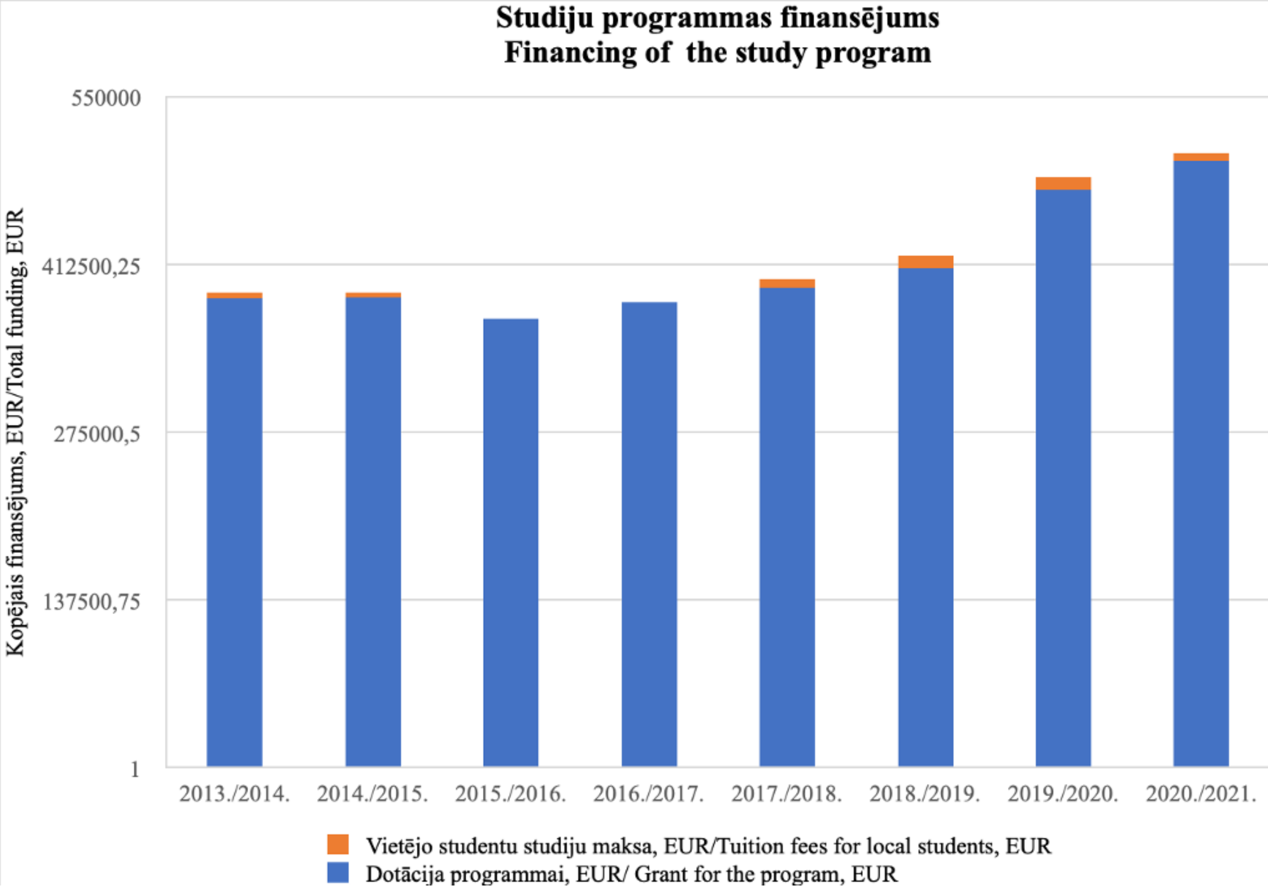
Study programme Funding

Academic year	State subsidy, EUR	Local student tuition fees, EUR	Total study programme funding, EUR	Funding of one state budget funded seat, EUR
2013/2014	384,199.00	5,110.00	389,309.00	3,866.00
2014/2015	385,436.19	4,230.00	389,666.19	3,866.02
2015/2016	367,654.83	511.54	368,166.37	3,866.02
2016/2017	381,168.36	0	381,168.36	3,866.02
2017/2018	393,087.27	7,522.28	400,609.55	4,040.66
2018/2019	409,559.84	9,870.00	419,429.84	4,229.68
2019/2020	473,092.11	10,760.00	483,852.11	4,405.04
2020/2021	497,364.89	6,564.14	503,929.03	4,462.81

Based on the 2015 “Study on Updating Study Cost Coefficients in Higher Education and Drawing of Proposals for their Consolidation”, as well as RTU empirical calculations and expert assessment, to ensure the cost-effectiveness of the study programme, RTU has determined that the academic Bachelor study programme must have at least 19 students in each academic year.

The distribution of funding is determined by RTU Regulations “On the Approval of the Funding Distribution and Utilization Methodology for RTU Organizational Units in Academic Year 2021/2022”. It determines the distribution of funding for RTU centralized services and organizational units that provide study courses. The full tuition fee per academic year is set at EUR 1,375.

The data on available funding are given in the graph below.



During the reporting period, the total financing of the study programme (consisting of subsidies for the programme and tuition fees of local students) has increased by 29%. The increase in funding per student has increased by 15%.

The increase corresponds to the general increase of prices in Latvia; however, the increase is smaller compared to the increase of prices on higher education in the world. Assessing the tuition fees of local students, it can be noticed that during academic year 2016/2017 no tuition fees were received, but in the next three years the rapid increase could be noticed, and in academic year 2020/2021 there was again a slight decline, which could be explained by the consequences of the pandemic and the inability to study for a fee. It can be concluded that, in general, students are interested in the academic study programme “Smart Computer Technologies”, and the subsidies for the program increase every year, thus ensuring the successful development of the study programme. All state budget funded seats are filled every year, which can be assessed as a positive trend in the development of the study field.

Detailed information on the breakdown of funding between cost items is provided in the Annex “Breakdown of funding between cost items” of the Self-Assessment Report. Information on the minimum number of students required for the study programme is given in the Annex to the Self-Assessment Report “Minimum number of students to ensure the cost-effectiveness of the study programme”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study programme comply with the conditions for the implementation of the study programme and the requirements of the regulatory enactments. All main instructors responsible for leading courses that are involved in the implementation of the study programme hold a PhD degree. All academic staff members who deliver lectures have at least a Master degree in engineering or computer science, while practical and laboratory work is mostly supervised by instructors holding a Master degree, and in some cases industry professionals with the necessary practical experience are involved.

In the reporting period, the number of instructors who have received a PhD degree has increased.

During the reporting period, four of the faculty members involved in the implementation of the program “Smart Computer Technologies” have received a PhD degree: assoc. prof. Dmitrijs Bļizņuks, assist. prof. Romans Taranovs (no longer working at RTU since 2021), assist. prof. Mihails Kovaļovs, lect. Artjoms Supoņenkovs.

The number of doctors involved in the implementation of the study program is 20 people and the total number of teaching staff 73 people. The total ratio of academic staff to visiting lecturers is four fifths.

In order to deepen students’ professional knowledge and in cases when the institute lacks the necessary specialists, visiting lecturers are attracted (see Table 3.2).

Table 3.2

Summary on the Involvement of the Guest Lecturers in Program Implementation

Name, surname of the guest lecturer	Organization	Date	Study course, activity	Contact hours
Ivo Lipste	*Ltd Colla*	2013 – 2021	“CAD/CAM technologies (special course)”	4
Ivars Karpičs	*European XFEL GmbH*	2020/2021	“Fundamentals of Computer Control”	4
Kristaps Skutelis	*Ltd Testdevlab*	10.2021	“Computer Control in Production Systems”, lecture “Automatics and Robotized Testing”	2

Gundars Miezītis	*RTU Design Factory*	09.2020	“Computer Control in Production Systems”, lecture “Prototyping Opportunities”	2
Ansis Avotiņš	*RTU KUKA Robot Laboratory*	10.2019	“Computer Control in Production Systems”	2
Arturs Agejevs	*ABB Latvia*	2018-2021	“Computer Control in Production Systems”	8
Kristaps Alcmanis	*Ltd Netcontrol*	2021	“Introduction to Industrial Systems SCADA”, lecture “Electric Supply SCADA”	2
Toms Mols	*Ltd Eligent*	2021	“Introduction to Industrial Systems SCADA”, lectures “PLC and Robot Automation”, “SCADA”	2
Arturs Agejevs	*ABB Latvia*	2017-2021	“Robot Control Systems”, lectures “Robotics and SCADA”, “PLC”	2
Stanislavs Hiļčuks	*Ltd ApplyIT*	25.10.2016. 01.10.2016.	“Introduction to Study Field”, lecture “Applications of Computer Vision”	4

The conformity of the academic staff to the requirements for the implementation of the study courses is proven by the data included in the CV of the academic staff and the research results (scientific projects, publications, presentations at scientific conferences, as well as contract work). According to the Law on Higher Education Institutions, the academic staff simultaneously with their academic activities also carry out research activities in the appropriate field. The academic staff are free to choose the field of research and to offer appropriate themes for PhD Theses. Some members of the academic staff also work at IT companies and, thus, practical skills and competencies are used in the implementation of the study program.

Brief summary of the academic staff is provided below.

Assoc. professor Dmitrijs Bļizņuks

Head of the Institute of Smart Computer Technologies. Associate professor and the author of 24 scientific articles indexed in SCOPUS. Articles relate to the topics of his study courses (computer control, computer networks). He has also led 7 scientific projects. He has also participated in qualification raising courses (more than 300 academic hours).

Assoc. professor Katrina Boločko

Associate professor, who delivers courses in image processing, computer graphics and computer vision. She is the author of 9 scientific articles and has participated in five scientific projects related to these areas. In order to improve her qualification, she participated in the Buffalo training program for Latvian teachers, during which she attended courses related to image processing and computer vision.

Assoc. professor Aleksandrs Sisojevs

Associate professor who delivers courses related to computer graphics. Aleksandrs is the author of 10 scientific articles and participated in 4 projects related to the courses.

Docent Mihails Kovaļovs

Assistant professor who has participated in two scientific projects in relation to the topics of his studies. Author of 7 scientific articles related to computer vision and three-dimensional computer graphics.

Lecturer Artjoms Supoņenkovs

Lecturer, author of 8 scientific articles and participated in 5 projects. Participates in several private companies as an expert in computer control system development.

Lecturer Matīss Eriņš

Lecturer who has been working on the Robot Control System in recent years, improving the curriculum in computer control manufacturing and SCADA systems; at least 10 Bachelor Theses have been developed under his supervision. Works in cooperation with ABB Latvia in the field of robotics. During the last six years, 2 international decision-making projects in the fields of medicine and physiology were successfully implemented. 5 scientific publications have been published and the course on expert systems and decision-making has been updated.

Lecturer Olga Krutikova

Lecturer, the author of 8 scientific articles related to computer science, image processing and computer vision. Undertook internship at PERUZA Ltd for the purpose of raising qualification.

Assistant Ints Mejiers

Assistant, working for several private companies as a computer networking expert.

Research assistant Andrejs Kalniņš

Research Assistant who has been maintaining and modernizing the computer systems of Riga State Gymnasium No. 1 for a long time.

Project manager Gundars Miezītis

Project Manager /Senior Expert at the Innovative Product Development Division. He has extensive practical experience in the development of equipment prototypes, works as an expert at RTU

Design Factory. Participated in one project.

Research assistant Evija Cibuļska

PhD student and research assistant who assists in conducting practical classes in courses related to image processing and computer graphics. Evija is the author of two scientific articles and has worked on two scientific projects related to the course. In order to improve her qualification, she participated in the continuing education course “Introduction to High-Performance Computing Technology” in the amount of 8 academic hours.

Lecturer Juris Lauznis

Lecturer, the author of 3 scientific articles, participated and managed 10+ local and international projects. European Commission expert – project evaluator HORIZON 2020, HORIZON EUROPE and related programs (FET, KE4CP, etc.); 25 projects were evaluated in the last 5 years.

Assistant Oļesja Grigorjeva

PhD student, research assistant, author of 5 scientific articles dedicated to medical expert systems and their development. 1st prize winner in the competition "The Best Research of Young Scientist" (14 May 2016).

Some of the teaching staff also worked in industry. For example, the assoc. prof. Dmitrijs Bliznuks works at SIA ARiTeh, which is related to industrial automation. Lect. Artjoms Suponenkovs works at SIA PERUZA, which deals with industrial automation and industrial computer vision. Lect. Aigars Riekstiņš works in the administration of computer networks of a state organization.

The close connection of the teaching staff with the industry ensures that the courses correspond to current trends in the industry and the labor market. Thanks to regular experience exchange seminars, the other teaching staff are also able to follow trends and rework courses according to the situation, which, in turn, ensures the relevance of the study program.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

Assessing the changes during the reporting period, it can be concluded that the academic staff has been renewed, which also affected the quality of studies. The most important changes are related to the replacement of older instructors with new specialists. As information technologies are developing rapidly, the attraction of new academic staff has encouraged the introduction of new courses to modernize the study program. In particular, the rapid increase in digital material can be noted, including the variety of video material needed to ensure full capacity learning during distance learning.

At the Department of Computer Graphics and Computer Vision (during the reporting period initially called the Professor Group of Image Processing and Computer Graphics):

- Professor Aleksandrs Glazs' study courses are taught by assoc. professor Katrina Boločko as the responsible instructor ("Fundamentals of Computer Graphics and Image Processing", "Fundamentals of Computer Graphics and Image Processing" (English course), "Introduction to Study Field", "Bachelor Paper").
    - The instructors implementing the study course "Fundamentals of Computer Graphics and Image Processing" are PhD Mihails Kovaļevs, lect. Olga Krutikova, lect. Evija Cibuļska.
    - The instructors implementing the study course "Fundamentals of Computer Graphics and Image Processing" (in English) are PhD Mihails Kovaļevs, lect. Olga Krutikova,
    - The instructor implementing the study course "Bachelor Paper" is lect. Olga Krutikov.
    - Responsible instructor for the study course "3D Animation in Maya" is PhD Mihails Kovaļevs.

New study courses were introduced in the academic Bachelor study program:

- Instead of the study course "Linear Automatic Control Systems", which was delivered by assist. prof. Jānis Avens-Aveniņš, a new study course "Fundamentals of 3D Graphic Modeling and Animation" was created, where the responsible instructor is assist. prof. Mihails Kovaļevs, but the instructor implementing the study course is lect. Olga Krutikova.
- The responsible instructor of the study course "Fundamentals of Interactive Computer Graphics" is assist. prof. Mihails Kovaļevs, but the executive instructor is Evija Cibuļska.
- The responsible instructor of the study course "Graphics in Smart Technologies" is assist. prof. Mihails Kovaļevs, but the instructor implementing the study course is Olga Krutikova.
- The responsible instructor of the study course "Mathematical Methods in Computer Graphics" is assoc. prof. Aleksandrs Sisojevs.

Department of Computer Control and Computer Networks (at the beginning of the reporting period it consisted of two units, the names of which were as follows: Professor Group of Computer Control Systems, Department of Computer Networks and Systems Technologies).

New study courses were introduced in the program:

- Instead of the study course "Fundamentals of Automation" taught by assist. prof. Jānis Salinieks, a new study course "Fundamentals of Computer Control" was created, where the responsible instructor is assoc. prof. Dmitrijs Bļizņuks, but the instructor implementing the course is research assistant Oļesja Grigorjeva.
- Instead of the study course "Microprocessor Engineering" a new study course "Embedded Systems" was created, where the responsible instructor is assoc. prof. Dmitrijs Bļizņuks, but the instructor implementing the course is research assistant Gundars Miezītis.
- Study course "Fundamentals of New Generation Smart Technologies", taught by assoc. prof. Dmitrijs Bļizņuks.
- Study course "Computerization of Decision-Making Tasks in Monitoring Systems", taught by assoc. prof. Dmitrijs Bļizņuks.
- Study course "Introduction to Computer Networks", where the responsible instructor is assoc. prof. Dmitrijs Bļizņuks, but the instructor implementing the course is assistant Ints Meijers.
- Study course "Internet of Things Technologies", where the responsible instructor is assoc. prof. Dmitrijs Bļizņuks, but the instructor implementing the course is assistant Ints Meijers.
- Study course "Fundamentals of Computer Technologies", where the responsible instructor is

assoc. prof. Dmitrijs Bļizņuks
- Study course “Fundamentals of Computer Technology Security”, where the responsible instructor is assoc. prof. Dmitrijs Bļizņuks, but the instructor implementing the course is assistant Ints Meijers.

For some of the courses, the responsible instructor was changed, for example:

- Instead of prof. Zigurds Markovičs, the study course "Computer Control in Production Systems" is delivered by lecturer Matīss Eriņš, and the responsible instructor is assoc. prof. Dmitrijs Bļizņuks.
- Instead of the responsible instructor Aigars Riekstiņš, the study course “Introduction to Computer Architecture” is delivered by the responsible instructor, assoc. prof. Dmitrijs Bļizņuks.
- Instead of the responsible instructor Zigurds Markovičs, the study course “Robot Control Systems” is delivered by lecturer Matīss Eriņš, and the responsible instructor is assoc. prof. Dmitrijs Bļizņuks.
- Instead of lecturer Aigars Riekstiņš, the study course “Computer Networks” is delivered by assistant Ints Meijers, and the responsible instructor is assoc. prof. Dmitrijs Bļizņuks.

Short quizzes were implemented in the study programs "Fundamentals of computer management", "Introduction to Computer Architecture", "Embedded systems" of the study program "Smart Computer Technologies" (previous name "Automation and computer engineering"), the study course "Introduction to computer networks" was used as a basis for quizzes.

Based on student survey results in 2020/2021 study year on the subject "Introduction to computer architecture" and comments about the fact that the lecture materials were pre-recorded and the teacher was unable to stay in front of the camera, the teacher conducting the lecture was changed from A. Riekstiņš to D. Blizņuks.

Based on the results of the student survey for 2020/2021 study year in the "Computer Networks" study course, teaching staff V. Zagurskis was replaced by implementing teaching staff D. Blizņuks due to poor English language.

Taking into account the students' comments in the results of the surveys (2015-2019) about the complexity of the programming of practical works in the study course "Fundamentals of Computer Graphics and Image Processing", in the study year 2020/2021. the Java programming language and the programming environment "NetBeans" were changed to the Python programming language and the Jupyter notebook programming environment, which significantly improved the students' results in the course.

During the period 2013-2021 some of teaching staff personnel retired, 8 people in total. Also, two doctors left for different reasons, one works in Germany and participates in the study process remotely as a guest lecturer, and the other works in industry.

The change of lecturers affected the study materials, which were improved and enhanced, as well as the final results of the study process. According to the results of the questionnaire, it can be concluded that the students' assessment of the quality of the study process was also positively influenced.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published

during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Within the framework of the study program, mutual cooperation between teaching staff is encouraged. Knowledge exchange seminars are held (at the faculty, institute and department levels), during which teaching staff have the opportunity to participate in the discussion and planning of the presentation of study course materials. An important concern is to avoid overlapping of the study courses. Therefore, the content of study courses is checked at the department level and often, some suggestions for course improvement are offered. An improvement in the course could be to supplement the course materials with examples from industry to explain to students how the theoretical knowledge gained can be applied in practice.

Several lecturers deliver study courses where the number of students exceeds 250 people. Responsible instructors deliver lectures, while other instructors conduct practical classes or laboratory work. Due to the rapidly evolving information technologies, the study materials available for the implementation of the study course are updated every year. Both the responsible instructor and the lecturers implementing particular courses are involved in this process; they adapt the materials of the practical classes based on the lecture notes, as well as taking into account the students' surveys and adapting the content. These materials are available to both lecturers who manage the study course and students. Evaluating the mutual cooperation, it can be concluded that this collaboration between the academic staff responsible for the courses and the staff implementing them allows creating quality materials and distributing the work among all the participants of the course.

In cases where additional teaching staff are invited, letters are sent out with an invitation to give lectures on one of the topics of interest. In this way, knowledge is exchanged between different departments.

The ratio of students and academic staff within the study programme is 12.33.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_DBF0(43526)_DiplPielik_LV_DiplSupplemt_ENG (1).zip	P28_DBF0(43526)_DiplPielik_LV_DiplSupplemt_ENG (1).zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	P29_DBF0(43526)_AIP_atzinums250stud_Automat_datortehn (1).edoc	P29_DBF0(43526)_AIP_atzinums250stud_Automat_datortehn (1).edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DBF0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.docx	P05_3.1.4_DBF0(43526)_StatistikaparStud_LV_StatisticsonStudents_ENG.docx
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DBF0(43526)_CompliancewiththeStateEducationStandard_AkadBak_ENG (2).docx	P06_3.2.1_DBF0(43526)_AtbilstibaValstsStandartam_AkadBak_LV 1.docx
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DBF0(43526)_Kartejums_lv_Mapping_eng.docx	P08_3.2.1_DBF0(43526)_Kartejums_lv_Mapping_eng.docx
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DBF0(43526)_Plans_lv_Plan_eng.docx	P09_3.2.1_DBF0(43526)_Plans_lv_Plan_eng.docx
Descriptions of the study courses/ modules	A10_DBF0(43526)_StudyCoursesdescr_ENG (3).zip	P10_DBF0(43526)_StudijuKursuapraksti_LV (3).zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Transport Electronics and Telematics (42523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Transport Electronics and Telematics*
Education classification code	*42523*
Type of the study programme	*Professional bachelor study programme*
Name of the study programme director	*Aleksandrs*
Surname of the study programme director	*Ipatovs*
E-mail of the study programme director	*aleksandrs.ipatovs@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	*+37129689893*
Goal of the study programme	*The aim of the study programme is to prepare specialists in the fields of transport telecommunications and transport radio electronics, who would be able to analyse the operation of wireless equipment and design telematics devices and systems according to requirements, as well as to prepare students for further academic or professional master's studies.*

Tasks of the study programme	*Tasks of the study programme:* *- to provide competitive professional education and qualification in accordance with international standards, and to prepare students for work in the field of telematics and transport electronic systems, to develop skills of scientific research work and to promote their use;* *- to develop and improve the basics of field-related fundamental sciences necessary for mastering theoretical study course;* *- to provide students with knowledge about the use of computer tools for analysing, modelling and designing transport electronics systems and programming individual modules of such systems;* *- to promote practical skills in solving telematics tasks at the project level and to provide a general understanding of transport electronics devices design, operation principles and automation, as well as existing modern transport telematics standards;* *- to ensure the development of study programme content, implementation of the study process, scientific research work and skills in accordance with changes in the fields of transport electronic systems and telematics, international practice and science;* *- to provide students with internationally competitive knowledge and develop competence in accordance with requirements of telecommunications and electronics engineering market, by preparing students for practical work in design and maintenance of telematics and transport electronic systems;* *- to develop students' skills to qualitatively search, filter and analyse the necessary information and use it during the decision-making process and solving problems in the corresponding field;* *- to provide students with knowledge about work organization, social issues, principles of economic activity and the impact of professional activities on the environment;* *- to promote interest of students for further professional development by providing knowledge and skills necessary for independent studies to improve academic and professional qualifications.*

Results of the study programme	*Graduate of the professional bachelor study programme:* *- knows the basics of field-related fundamental sciences necessary for mastering theoretical study courses;* *- is proficient at concept level in wired and wireless transport telecommunications networks, key technologies, and standards;* *- is proficient at concept level in electrical circuits and signal processing;* *- is proficient at concept level in standards and technical regulations of the electronics industry;* *- is proficient at concept level in basics of operation and measurement methods, methods of telecommunication networks and systems design and analysis;* *- is proficient at application level in transport electronics and telematics equipment principles of operation;* *- is proficient at application level in electronic components, analogue, digital and radio electronic devices;* *- is proficient at application level in programming of microcontrollers and microprocessors by using high-level languages;* *- is proficient at application level in real-time transport radio and navigation systems;* *- is proficient at application level in transport intelligent and sensor systems;* *- is able to perform experimental data processing for analysis of telecommunications and transport electronic systems operation;* *- is able to systematize the related information, summarize, interpret and analyse results of measurements and calculations, prepare summarized reports and present them;* *- is able to apply latest technologies and software for the design of transport electronic systems and data transmission systems;* *- is able to design electronic equipment and systems, simulate its operation, develop applications and algorithms for solving specific tasks;* *- is able to design printed circuit boards and the appropriate technical documentation;* *- is able to work with scientific, technical and methodological literature in foreign language;* *- can work individually and as a part of a team, to continue learning in the field of transport telecommunications and data transmission, to act in a sustainable, ethical and responsible manner not to harm society and environment.*
Final examination upon the completion of the study programme	*The state examination, where the elaboration and defence of a bachelor’s thesis including a project is a constituent part of this examination in a public session.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*

Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional bachelor degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional bachelor degree in transport electronics and telematics*
Qualification to be obtained (in english)	*Electronics engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

Bachelor’s professional study programme “Transport electronics and telematics” has been implemented since 2004. The last accreditation certificate for the programme was issued on 31.05.2013. (certificate No. 2020/80).

The study programme volume is 160 CP or 240 ECTS. The implementation form is full-time (4 years). The full-time studies of the programme are implemented according to standard RTU plan: 2 semesters per study year, each 20 weeks long – 16 study weeks and 4 session weeks. general or 4-years vocational secondary education is a requirement to enroll for this study program. The study programme is being implemented in Latvian and English languages.

During the review period of the programme, the following significant changes were made to improve the study programme content and a form of providing students with latest theoretical knowledge and practical skills required to work in a chosen profession.

The following significant changes to the study programme were introduced after the date of the previous study direction certificate was issued:

1. the profession classification code was changed from 2151 01, 2151 20 to 2152 01;
2. the part-time and extramural implementation forms of studies were excluded. Since 2017, all students of part-time study programme were transferred to full-time study programme and admission to part-time study programme was discontinued;
3. the responsible institution has been changed from 13010 Transport electronics and telematics group to 13107 Telematics and transport electronic systems group;
4. a new director Asoc. Prof. Aleksandrs Ipatovs was elected to manage the study programme;
5. a specialization direction “Railway transport telecommunication and information systems” was removed;
6. the volume of compulsory courses part (A) was reduced from 89 CP to 88 CP:
    - the following courses were **excluded** from compulsory courses part (A): RTR105 Computer Studies (basic course) 3KP, IET103 Economics 2CP, TRT101 Introduction to Study Field 1CP, TRT223 Electrical Engineering Theory 4CP, RTR108 Computer Studies (special course) 2CP, HPS120 Basics of Communication 2CP, RRE102 Electricity and Magnetism 2CP, IDA102 General and Occupational Safety 1CP, TRT218 Metrology 3CP, TRT225 Basics of Signal Theory 3CP, TRT330 Transmission of Information and Transport Digital Communication Systems 4CP, TRT317 Basics of Communication Systems 2CP, TRL203 Transport Real-Time System Maintenance 2CP, EDS412 Transportation Communication Lines 3CP, EDS425 Transport Telecommunication System Channelforming Equipment (study project) 2CP, EDS424 Transport Telecommunication System Channelforming Equipment 2CP;
    - the following courses were **included** to compulsory courses part (A): RDE710 Introduction to Electronics and Telecommunications Branch 4 CP, SDD700 Innovative

Product Development and Entrepreneurship 6 CP, TRT441 Computer Technologies in Research 4CP, VAS038 Environment and Climate Roadmap 1CP, RDE707 Telecommunications Theory 6CP, TRT409 Intelligent Transport Systems 4CP, TRL329 Transport Real-Time System E-Business 3CP, TRL301 Design of Telecommunication Equipment Devices (study project) 2CP, TRL341 Data Collection Systems in Intellectual Vehicles 3CP, TRT311 Transport Telecommunication Systems 3CP, RDE302 Transmission Media 6CP, RAE306 Digital Switching Systems 4CP, RRE102 Electricity and Magnetism 2CP, REA103 Fundamentals of Materials Science 2CP, RTR821 Antenna Design 3CP, RDE706 Transmission Systems 6CP, RDE711 Mobile Network Architecture 4CP, RTR207 Computerization of Mathematical Tasks in Electrical Engineering 3CP, TRL337 Advanced Computer Networks in Transport Systems 4CP;

7. the volume of compulsory elective courses part (B) was increased from 27 CP to 34 CP, the volume of field-specific compulsory elective courses part (B1) was increased from 21 CP to 26 CP and the volume of humanities and social sciences courses part (B2) was increased from 2 CP to 4 CP;
    - the following courses were **excluded** from field-specific compulsory elective courses part (B1): TRT353 Fundamentals of Computer Architecture 3CP, TRT414 Fundamentals of Radio Location 3CP, EDE459 Railway Digital Communication Systems 3CP, EDE580 Railway Telecommunication Systems 4CP, EDR306 General Course of Railway 2CP, EDE457 Railway Telecommunications and Computer Network 3CP, TRL417 Integrated Services Digital Network 3CP, TRT310 Radio Transmitting and Radio Receiving Devices 4CP, TRT452 Satellite and Microwave Systems for Transportation 2CP, TRL329 Transport Real-Time System E-Business 3CP, EDE458 Railway Mobile Communication Systems 3CP, EDE352 Railway Communication Systems 5CP, TRT409 Intelligent Transport Systems 4CP, TRT352 Electrodynamic and Microwave Engineering Elements 4CP, TRT451 Video Technique (special course) 4CP, TRT441 Computer Technologies in Research 3CP, EDS302 Transportation Fiber Optics Transmission Systems 3CP;
    - the following courses were **included** to field-specific compulsory elective courses part (B1): RDE302 Transmission Media 6CP, RAE306 Digital Switching Systems 4CP, RRE102 Electricity and Magnetism 2CP, REA103 Fundamentals of Materials Science 2CP, RTR821 Antenna Design 3CP, RDE706 Transmission Systems 6CP, RDE711 Mobile Network Architecture 4CP, RTR207 omputerization of Mathematical Tasks in Electrical Engineering 3CP, TRL337 Advanced Computer Networks in Transport Systems 4CP;
    - the following courses were **excluded** from humanities and social sciences courses part (B2): HSP377 Vispārējā socioloģija 2KP, HSP376 Mazās grupas un personības socioloģija 2KP;
    - the following courses were **included** to humanities and social sciences courses part (B2): HPS120 Basics of Communication 2KP, IRO415 Organization of Production 2KP;
8. the volume of internship part (D) was reduced from 26 CP to 20 CP.

To provide a modern education compliant to demands of the field, the changes introduced to the study programme aim to improve the study process and its quality by considering recommendations received from leading field enterprises and graduates, as well as development trends of modern technologies.

As a part of the study field evaluation procedure, it is planned to change the admission requirements to "general or vocational secondary education" from "general or 4-years vocational secondary education".

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The professional bachelor’s level study programme "Transport Electronics and Telematics" is elaborated in accordance with the Law on Higher Education Institutions of the Republic of Latvia and in accordance with Classification of Education of the Republic of Latvia.

For implementation and development of the study programme in the course of time, principles of Latvian classification infrastructure (LKI) and European classification infrastructure (EKI) are observed.

The study programme is developed taking into account RTU strategic objectives, market offers and potential demands.

The study programme is elaborated according to the RTU strategy and the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science”. Acquisition of knowledge and skills anticipated in the study programme is provided by the academic staff and scientists of the European level. During the implementation of the study programme, innovative study methods are used - the use of more practical and modern technologies.

The study program is included in the study direction “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which is characterized by a set of study programs whose main focus is on the use of technology and scientific knowledge specific to the direction in the study process.

General or vocational secondary education is a requirement for applying for studies. The duration of studies is 4 years, and the volume of study courses to be completed amounts to 160 CP.

The title of the study programme "Transport Electronics and Telematics" is fully in line with study direction “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science" since electronics is included in the title of the direction as an integral part. At the same time, telematics is based on the fields of Telecommunications and Informatics (Computer Science), which also match the study direction.

The study programme's classification code 42523 - "Electronics and automatics" was chosen based on relation of the study programme title, goals, contents and assigned degree to electronics and telematics, which also includes automation solutions and corresponds to engineering sciences.

Applicants with general or vocational secondary education can be admitted to the programme. The admission of full-time studies applicants to the programme is performed based on results of centralized examinations (CE) in mathematics, Latvian language, foreign language, physics and/or chemistry.

Graduates of the study programme acquire a professional bachelor’s degree in transport electronics and telematics, and also a qualification of electronics engineer. Graduates of the study programme can continue their studies in master level study programmes, such as professional programme

“Transport electronics and telematics”.

The strategical goal within the existing scope of RTU strategy is to facilitate internationally competitive high quality scientific research, higher education, transfer of technology in fields of telematics and transport electronic systems, by setting faculty level strategical tasks – high quality study process, excellent research, sustainable commercialization/valorization. The goals and tasks of the study programme are defined in accordance with results of the surveys on interests and requirements for graduates coming from interested parties (potential employers, universities, students, society and scientific institutions).

The aim of the study programme is to prepare specialists in the fields of transport telecommunications and transport radio electronics, who would be able to analyse the operation of wireless equipment and design telematics devices and systems according to requirements, as well as to prepare students for further academic or professional master's studies.

Tasks of the study programme:

- to provide competitive professional education and qualification in accordance with international standards, and to prepare students for work in the field of telematics and transport electronic systems, to develop skills of scientific research work and to promote their use;
- to develop and improve the basics of field-related fundamental sciences necessary for mastering theoretical study course;
- to provide students with knowledge about the use of computer tools for analyzing, modeling, and designing transport electronics systems and programming individual modules of such systems;
- to promote practical skills in solving telematics tasks at the project level and to provide a general understanding of transport electronics devices design, operation principles and automation, as well as existing modern transport telematics standards;
- to ensure the development of study programme content, implementation of the study process, scientific research work and skills in accordance with changes in the fields of transport electronic systems and telematics, international practice and science;
- to provide students with internationally competitive knowledge and develop competence in accordance with requirements of telecommunications and electronics engineering market, by preparing students for practical work in design and maintenance of telematics and transport electronic systems;
- to develop students' skills to qualitatively search, filter and analyze the necessary information and use it during the decision-making process and solving problems in the corresponding field;
- to provide students with knowledge about work organization, social issues, principles of economic activity and the impact of professional activities on the environment;
- to promote interest of students for further professional development by providing knowledge and skills necessary for independent studies to improve academic and professional qualifications.

After acquisition of the study programme the graduate (**planned achievable results**):

- knows the basics of field-related fundamental sciences necessary for mastering theoretical study courses;
- is proficient at concept level in wired and wireless transport telecommunications networks, key technologies, and standards;
- is proficient at concept level in electrical circuits and signal processing;
- is proficient at concept level in standards and technical regulations of the electronics

industry;
- is proficient at concept level in basics of operation and measurement methods, methods of telecommunication networks and systems design and analysis;
- is proficient at application level in transport electronics and telematics equipment principles of operation;
- is proficient at application level in electronic components, analogue, digital and radio electronic devices;
- is proficient at application level in programming of microcontrollers and microprocessors by using high-level languages;
- is proficient at application level in real-time transport radio and navigation systems;
- is proficient at application level in transport intelligent and sensor systems;
- is able to perform experimental data processing for analysis of telecommunications and transport electronic systems operation;
- is able to systematize the related information, summarize, interpret and analyse results of measurements and calculations, prepare summarized reports and present them;
- is able to apply latest technologies and software for the design of transport electronic systems and data transmission systems;
- is able to design electronic equipment and systems, simulate its operation, develop applications and algorithms for solving specific tasks;
- is able to design printed circuit boards and the appropriate technical documentation;
- is able to work with scientific, technical and methodological literature in foreign language;
- can work individually and as a part of a team, to continue learning in the field of transport telecommunications and data transmission, to act in a sustainable, ethical and responsible manner not to harm society and environment.

Measurements of the study programme results are reflected in study results of students, employment of the graduates, feedback from employers, enhancement of international cooperation, increase of the number of projects, increase of the number of students involved in the research process, the approbation of the research results.

The title of the study programme, the obtained degree, objectives, tasks and achievable results are mutually linked and comply with modern young professionals needs and employers demands.

The programme with its activity promotes the keynote defined in the RTU Strategy for 2021 – 2025: ”High quality and effectiveness – proactive linkage between RTU activities and needs of the national economy. RTU is one of the leading science and technology universities in the Baltic and Nordic region, which is acting based on a study system built on research, innovation and cooperation with the industry. RTU prepares European and global-level engineers – leaders: developers of new technologies”, and implements it in real life.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

National Development Plan of Latvia for 2021-2027 states that ICT achievements and their widespread availability are a catalyst for change in the national economy, public administration, and society as a whole. The society knowledges, through the targeted use of ICT solutions, are transforming existing and creating new processes, business models, habits, and cultures in all areas of economy and life. The digital transformation is a key to productivity, economic growth, well-being of the individual and society. At the same time, according to Digital Economy and Society Index compiled by European Commission in 2018, the number of ICT specialists in Latvia accounted for was only 2.2% of all employees, which is significantly below the European Union (EU) average, or 3.7%. Industry research conducted by the Certus think tank in 2017 “Future goals, present directions. Latvia 2022” revealed, that Latvian IT industry needs up to 3,000 new graduates annually.

According to the Latvian Statistics Portal, a share of companies employing ICT / IT specialists has increased by 5% over the last 7 years and reached 73% in 2020. According to the Certus think tank industry study conducted in 2019, “Regional Competitiveness. Latvia's Competitiveness Report 2019”, salaries for ICT specialists in leading EU countries are about 30% above the national average, in Latvia this difference reaches 80%.

The telematics and transport electronics industry in Latvia and all around the world has been developing steadily in recent years, and the quality of transport telecommunications infrastructure is at a high level. The industry key performance indicators are growing and synergies with economy and other sectors of the economy will be important for telematics industry in the future. The economic and / or social justification of the study programme is based on performed research of industry and employment of graduates.

The employment of graduates is an important indicator that shows the demand for study programme prepared specialists in labor market. The employment of graduates of the study programme “Transport Electronics and Telematics” is high, and the surveyed graduates make a career in acquired profession. Graduates mostly work in transport and telecommunications companies, IT companies, universities, scientific research institutions, industry manufacturing plants both in Latvia and abroad.

The fourth semester students have an internship in one of the industry's companies or organizations. Many employers post internship offers at the portal prakse.lv or send them directly to the management of study programme. Upon completion of the internship, the employer sends feedback to the programme director describing the results achieved. In general, employers have expressed a positive opinion about preparation of students at the study programme for internship and work. After the internship and Bachelor Thesis are publicly presented, students often continue their work in the same companies where the internship took place.

Graduates of the study programme can become consultants, engineering network designers, technicians, engineers, infrastructure specialists, telematic systems analysis and monitoring specialists, transport infrastructure solution development and implementation specialists. The knowledge acquired during studies allows graduates to take leading positions in private companies or State institutions, as well as to manage engineering projects in the most modern technologies.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

The professional bachelor’s level study programme “Transport electronics and telematics” is full-time programme studied in Latvian and in English. The analysis on implementation in English language hasn't been made, since there were no students in English groups during the review period. Still, several study courses of the study programme are implemented in other RTU study programmes in English. During the review period, an average of 51 students were studying in the programme. The dynamics of number of students is shown in Fig. 1.

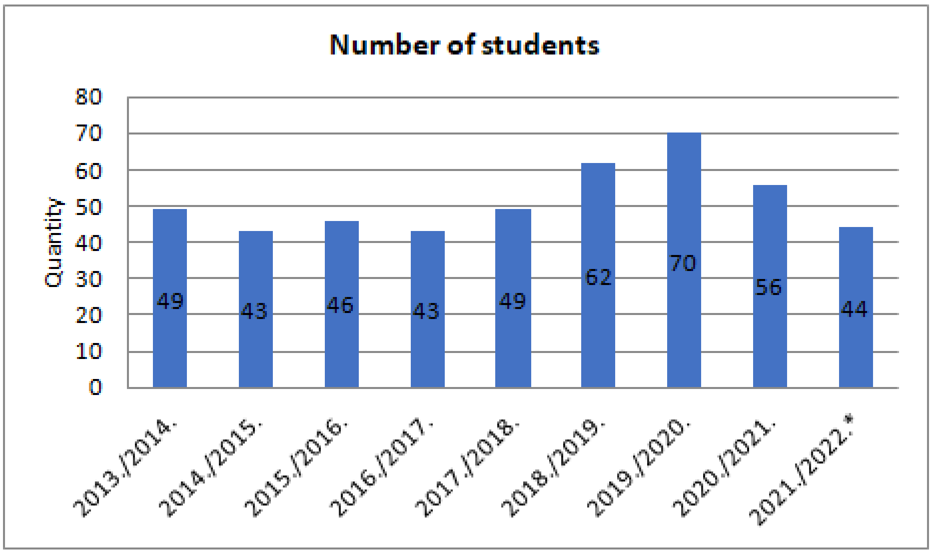


Fig. 1.: Dynamics of number of students of professional bachelor's level study program "Transport electronics and telematics" during the review period. *Data presented by 15.02.2022.

The fluctuations of the number of students is related to centralized examinations results for school graduates (specifically, for exact study courses), socially-economic situation in a state (employment, migration), field development trends in Latvia and abroad. Figure below displays distribution of the students by study years.

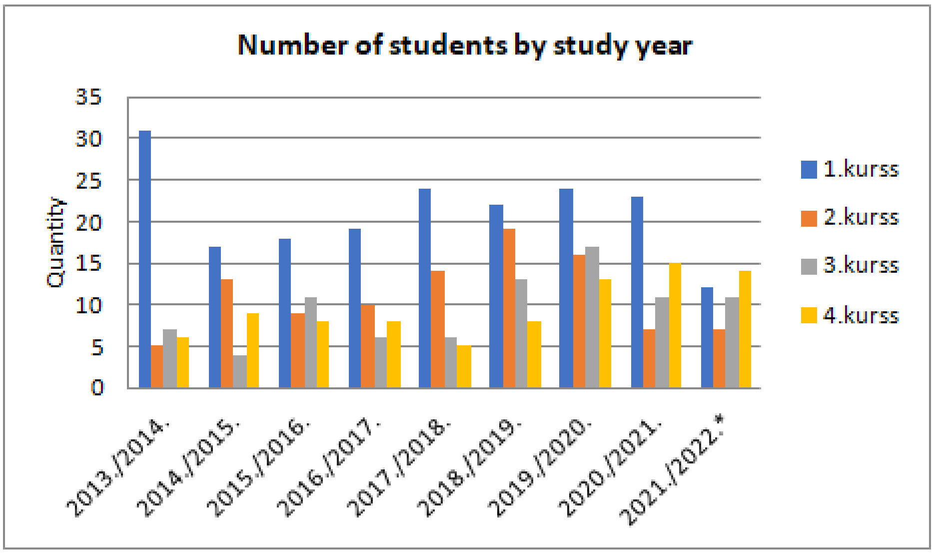


Fig. 2.: Number of students of professional bachelor's level study program "Transport electronics and telematics" during the review period distributed by study year. *Data presented by 15.02.2022.

There were 48 graduates in total for the study programme in time interval from 2013/2014 academic year to 2020/2021 academic year. The dynamics of graduates is displayed in figure below.

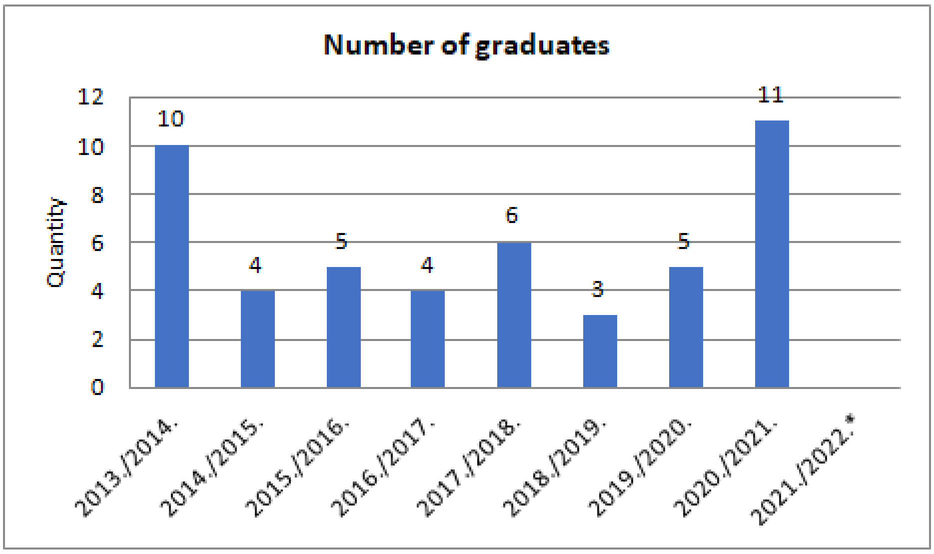


Fig. 3.: Number of graduates of professional bachelor's level study program "Transport electronics and telematics" during the review period. *Data presented by 15.02.2022.

A comparison of the number of the 1-st study year enrolled students and number of graduates shows dropouts. However, these dropouts reduced in 2021/2022 study year because of introduced improvements for study process and study programme in general. The highest student dropouts were observed for the 1-st and the 2-nd study year students because of academic failure. In 2023/2024 study year high dropouts are also expected due to Covid-19 introduced restrictions.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

Not applicable.

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The study programme is focused on practical applicability for transport computer systems and telematics. The students acquire theoretical knowledge on electronics, telecommunications, and computer systems in amount necessary for further study of practical exercises during the studies The courses of study programme professional specializations are combined in three modules: transport telecommunications; transport computer systems and networks; transport radio-electronic systems. The practical skills of students are developed and improved not only through working on course projects and practical exercises, but also by completing four months long internship at Latvian transport, information technologies and telecommunications companies. Also, students are offered to participate in study visits to the field enterprises.

During the study programme acquisition, students are involved with project development tasks by working on course projects and preparing reports in accordance with defined requirements of technical documentation. The amount of knowledge acquired during the studies and mastered practical skills meet the requirements of profession standard “Electronics engineer”. As the conclusion of the study programme, students develop and defend their thesis works with project part and afterwards are granted both bachelor’s level degree and qualification of electronics engineer according to the 5-th qualification standard’s level. After completing their studies, graduates can continue their studies by enrolling to professional master’s study programme.

The study programme has been accredited several times, the last accreditation was in 2013 (Accreditation page No 2020/80) and the accreditation expiration date is 30th of June, 2023. The place of implementation of the study programme is Riga. The type of implementation is full-time intramural studies (4 years). In the standard planning of RTU in each study year, there are 2 semesters, the length of each semester is 20 weeks - 16 study weeks and 4 session weeks.

The contents of the study programme is updated according to development trends of labor market and science. The study programme is improved annually by considering results of student surveys and recommendations of employers and graduates. The vision of bachelor’s level programme “Transport electronics and telematics” is implemented based on opinions of students, graduates, employers, professional and non-government organizations, considering the direction defined by Latvian development plans and match RTU mission and vision, goals, and tasks.

The competitiveness of the study programme is demonstrated by demand of graduates on the labor market after graduation of the programme. The information of the study courses complies with a goal of the study programme – to provide students with knowledge and practical skills. The study programme ensures a link between information of the study courses, achieved results, defined goals, methodology and each study course are linked to the goals and achieved results of the study programme. The goal of the study programme is developed in accordance with the trends of the profession and needs of the economy and society. The programme tasks are designated to educate students in accordance with requirements of the 5-th level of Latvian qualification framework, and to promote competitiveness of the students in mutable socio-economic conditions and international labor market.

The study programme is implemented in a form of lectures and practical classes with considerable time dedicated to independent studies. The contents of the study programme comply with regulatory requirements and is designed in accordance with the provisions of RTU Senate decision “About common requirements for study programmes”.

The total duration of the studies is 4 years divided into 8 study semesters of compulsory, field-specific and free-choice study courses. The studies are concluded by internship at field-related enterprise and development of bachelor’s thesis work with project part.

The programme utilizes multiple principles of study courses selection and acquisition. Those study courses aimed at providing minimum required field-related knowledge and skills are compulsory part of the study programme and all students are enrolled in such courses. The study courses that expand this knowledge and concepts or provide in-depth development of specific skills are compulsory elective part of the study programme and students must choose the courses to meet the minimum limit defined by the study programme according to a specialization. The students can choose one of the following specializations: Transport radio-electronic systems, Transport telecommunications, Transport computer systems and networks.

The volume of compulsory study programme courses is 88 CP (135 ECTS). The compulsory study courses develop knowledge and skills of the students and promotes knowledge and skills on scientific research methods and their application. The compulsory elective (specialized) study courses (26 CP or 39 ECTS) are intended to enable future specialists to obtain in-depth knowledge in their selected specialization field. The study programme also includes humanities and social sciences study courses (4 CP or 6 ECTS), language study courses (4 CP or 6 ECTS) and free elective study courses (6 CP or 9 ECTS). Students of English language implemented study programme are entitled to choose Latvian study course “English for foreign students” in the amount of 1 CP (VLS711). The student concludes the study programme with internship at the field-related enterprise (20 CP or 30 ECTS) and development of bachelor’s thesis work with a project part (12 CP or 18 ECTS).

Table 1: The study programme composition by study courses.

No	Code	Name	Credit points
A		**Compulsory Study Courses**	**88.0**
A1		**General Education Study Courses**	**16.0**
1	RDE710	Introduction to Electronics and Telecommunications Branch	4.0
2	SDD700	Innovative Product Development and Entrepreneurship	6.0
3	TRT441	Computer Technologies in Research	3.0
4	IDA700	Basics of Labour Protection	1.0
5	ICA104	Civil Defence	1.0
6	VAS038	Environment and Climate Roadmap	1.0
A.2		**Field-Specific Theoretical Basic and IT Study Courses**	**38.0**
1	DMF101	Mathematics	9.0
2	DIM205	Supplementary Mathematics (for electrical engineering)	2.0
3	DMS212	Probability Theory and Mathematical Statistics	2.0
4	MFA105	Physics	6.0
5	TRT215	Fundamentals of Circuit Theory	3.0
6	RDE709	Electrical Measurements in Telecommunications	4.0

7	RAE261	Digital Electronics and Computer Architecture	3.0
8	TRT203	Semiconductor Devices	3.0
9	RDE707	Telecommunications Theory	6.0
A.3		**Field-Specific Professional Study Courses**	**34.0**
1	TRT273	The Basics of Control Theory	2.0
2	TRT315	Transport Microprocessor Systems	2.0
3	TRL244	Computer Networks	2.0
4	TRT305	Computer Modelling of Transport Electronic Systems	3.0
5	TRT226	Analogue Devices	4.0
6	TRT316	Design of Transportation Systems in Real-Time	2.0
7	TRT409	Intelligent Transport Systems	4.0
8	TRL329	Transport Real-Time System E-Business	3.0
9	TRT314	Transport Microprocessor Systems (study project)	2.0
10	TRT313	Real-Time Communication Systems (study project)	2.0
11	TRL301	Design of Telecommunication Equipment Devices (study project)	2.0
12	TRL341	Data collection systems in intellectual vehicles	3.0
13	TRT311	Transport Telecommunication Systems	3.0
B		**Compulsory Elective Study Courses**	**34.0**
B1		**Field-Specific Study Courses**	**26.0**
		Transport radio-electronic systems	
1	TRT412	Fundamentals of Radio Navigation	3.0
2	TRL516	Communication in Intelligent Transportation Systems	4.0
3	RDE302	Transmission Media	6.0
4	RAE306	Digital Switching Systems	4.0
5	RRE102	Electricity and Magnetism	2.0
6	REA103	Fundamentals of Materials Science	2.0

7	RTR821	Antenna Design	3.0
		Transport telecommunications	
1	TRT309	Mobile Communication Systems in Transportation	3.0
2	TRT508	Transport Electronic Control Systems	2.0
3	RTR107	Introduction to Computers and Algorithms	2.0
4	RDE302	Transmission Media	6.0
5	RAE306	Digital Switching Systems	4.0
6	RDE706	Transmission Systems	6.0
7	RDE711	Mobile Network Architecture	4.0
		Transport computer systems and networks	
1	TRL415	Network Databases and Databanks	3.0
2	TRL326	Network Reliability	3.0
3	TRL534	Computer Network Monitoring, Diagnostics and Maintenance	3.0
4	TRL519	Local Area Networks	4.0
5	TRT461	The C Programming Language	2.0
6	RTR207	Computerization of Mathematical Tasks in Electrical Engineering	3.0
7	TRL337	Advanced Computer Networks in Transport Systems	4.0
B2		**Humanities and Social Sciences Study Courses**	**4.0**
1	HSP375	Sociology of Management	2.0
2	HSP379	Political System of Latvia	2.0
3	HSP380	United Europe and Latvia	2.0
4	HPS120	Basics of Communication	2.0
5	IRO415	Organization of Production	2.0
B6		**Languages**	**4.0**
1	HVD101	The English Language	2.0
2	HVD216	The English Language	2.0

3	HVD415	The German Language	4.0
C		**Free Elective Study Courses**	**6.0**
D		**Practical Placement**	**20.0**
1	TRT014	Practical Placement	20.0
E		**Final Examination**	**12.0**
1	TRT012	Bachelor Thesis Including Project	12.0

Lecture courses are generally theoretical with research elements embedded in the form of survey and/or research reports and other independent works during the studies. The focus of practical classes is individual for each student in a form of individual study project development. The study programme envisages development of 3 study projects. The acquisition of knowledge, skills, and abilities in special study courses is supervised in the form of individual consultations. The attendance to practical classes is mandatory for all students during their studies.

For each study course the students are expected to take all tests, develop their individual homework, and course projects. Final examination is allowed only to the students who have fulfilled all the requirements of the study programme. The results of examination are recorded in the electronic database of RTU studies management system. Development of the bachelor's thesis work with project part involves reviews of the development process, where students present the progress of their research to responsible instructors and demonstrate results of project part development.

The study courses are constantly improved and supplemented whenever responsible instructor considers it necessary. At the same time, it should be noted that all instructors involved in implementation of the study programme are also research staff, which is reflected in lecturer's publications and project participations.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

Not applicable to professional study programme.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study

process.

The study programme is implemented by joining theoretical and practical knowledge and skills in the form of lectures, seminars and practical activities. In the study programme the study courses and elaboration of the graduation paper are proportionally distributed by semesters so that they append each other by providing students acquisition of the targeted knowledge and skills. In general the study programme and each semester plan are created by focusing on acquisition and strengthening of theoretical and professional skills of each student by working individually or in a team.

Assessment of study results takes place according to the Regulation for assessment of learning outcomes (only in Latvian) and the Regulation for final examinations at Riga Technical University (only in Latvian).

The teaching staff responsible for the study courses, according to course content and programme specification, as well as student needs, choose the structuring, teaching and evaluation methods of the study courses. There are courses and seminars organized for the academic staff about the newest pedagogical methods, as well as attendance to qualification raising and upgrading courses is promoted within the Faculty, RTU and worldwide. RTU academic excellence centre organizes academic staff training events at the university level.

The study program is implemented in Latvian and English and provides for full-time studies. When implementing the content of the program, the requirements formulated in regulatory acts and the basic principles of study process organization determined by RTU are taken into account, as well as all study course requirements are met. The course descriptions of the study program define a set of relevant knowledge, skills and competencies and their evaluation system. The intended study results are defined, for the achievement of which credit points are awarded. The full-time type of study corresponds to 40 CP in the academic year. In bachelor's studies, 50% of the workload is contact hours and 50% is independent work.

The methods used in the study programme promote the acquisition of objectives and results of the study courses and the programme. In improving the study process students can express their wishes to the teaching staff of the certain study course, the head of the group, the programme director or with the help of student self-government, representatives of which are members of the Council of the Faculty of Electronics and Telecommunications (FET), RTU Senate and RTU Senate commission as well as members of RTU Academic council. FET make relationships with students on the basis of principles of mutual trust, respect and integrity. Students are provided with an opportunity to influence own process of studies, to implement own autonomy, to submit feedback on the process of studies by combining it with own professional growth interests. Large role in provision of linkage among students, teaching staff and programme administration is given to the FET student self-government, which actively takes part in all the mentioned processes and performs annual assessment of the teaching staff.

When starting the study course, the teaching staff inform students about requirements for acquisition of the study course and introduce to students the assessment criteria of the study course. All information is published in the electronic environment of study courses ORTUS. Once per semester students assess work of the teaching staff in the ORTUS environment by answering a questionnaire. This includes assessment of the advancement of studies, individual tasks, acquired skills, relationship and cooperation of a teacher with students. Questionnaires are anonymous.

In the study programme complete implementation of study results is provided. The study results are formulated both at the study programme level and at the study course level. The achievable learning outcomes are discussed with students in the beginning of each study course, and also such information is available in the ORTUS environment. A linkage is provided between achievable results of the study programme and those of the study courses. According to the achievable results of the study programme, content, and volume in credit points of study courses is created, and in its turn, according to the achievable results of the study course, topics and volume thereof are created. In all study courses the achievable results are verified with the corresponding assessment methods.

During the implementation process the study programme is appended and updated based on science development, labour market research and consultations with employers and practising experts. Recommendations received from graduates, students and teaching staff of the university are significant for improvement of the study process.

Many various study methods are used in the pedagogical process: individual and group work, individual and group consultations, presentation of results, project work, tests, verbal and written examinations, practical laboratory works, discussions etc. At the beginning of each study course, the lecturer explains to the students the study course goal, determines the knowledge level of the students and their former experience. To the extent possible, the teaching staff and students agree on the studies process, methods, assessment etc. When teaching methods are combined, their suitability to different groups of students is maintained, so that the students with different needs can acquire knowledge and skills in the most suitable way for them.

During the studies, the student-centered approach is adopted. In order to ensure student-centered education, students are offered a relatively high degree of autonomy in the development of independent work, implementation of specific undergraduate paper research, and the choice of a particular major, as well as in group work, which to a large extent also allows the manifestation of organizational skills, leadership qualities and other transdisciplinary skills.

A significant role is given to independent learning of students. Description of independent work is included into the description of the study course as a compulsory component. Ability of students to learn independently is purposefully developed in all study courses. Students acquire practical and research work skills by regular use of literature and Internet resources, including international scientific databases, which are available at RTU library with electronic access to the ORTUS environment, to successfully elaborate research study papers.

The centre of RTU structural units, including staff, science, international relations, studies and also Academic excellence regularly inform the staff about opportunities to improve their competencies in scientific research and methodological and digital skills in the field of general competencies and specific professional activity. In the ORTUS environment information about scientific activity of the academic staff is stored. To perform pedagogical work at high level, methodological seminars are organizing for RTU teaching staff about opportunities of application of various learning methods, experience and best practices.

Academic staff of the programme regularly improve the content of studies by introducing to the study process new, innovative study organisation and learning methods, the main objective is to teach how to learn, look for information, use various sources of information, discuss, work together with others, make decisions and take responsibility. Cooperation here is done in both directions, student - student and teacher - student. International experience is integrated into the study process.

Analyzing the study implementation and results in evaluation methods used in the study program, it must be concluded that the principles of student-centered education are consistently observed:

- the student contingent and the diversity of their needs are taken into account and respected when creating suitable learning paths;
- different ways of implementing the study program have been used;
- guided by the student’s abilities and needs, the teaching staff uses diverse pedagogical methods and encourages the student's desire for independence, while at the same time providing the teacher's guidance and support;
- the conduct of the study process in the study program promotes mutual respect in the relationship between students and teaching staff, as the principle of democracy is observed and the administration of the study program takes into account the opinion of students.

Overall, it can be considered that the materials and methods used within the program correspond to the achievement of the aims of the study program, as well as provide sufficient diversity for the use of student-centered teaching practices in everyday life.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

During the internship, students get acquainted with the company structure and its operation organization, as well as economic indicators of the undertaking. Students are provided with an opportunity to master the latest scientific and innovative technical solutions in the field of transport electronics and telematics. Internship is organized during the final year of studies and its volume is 20 CP, of which 12 CP are obtained during the seventh semester and 8 CP during the eighth semester. The internship tasks, where activities to be performed and deadlines are provided, are formulated in accordance with the requirements of the undertaking and the study program and are monitored by the internship manager at the undertaking. During the internship, regular consultations with the internship manager at the undertaking and the internship coordinator at the university are scheduled in accordance with the instructions of the organizational unit. During the first part of the internship (12 CP), students master work in a team, including acquainting with safety regulations, basic principles of technology process control, systems, its elements, software, and technological process documentation. Students can utilize transport electronics and telematics systems, are able to independently learn new technologies and evaluate possible solutions for their implementation, know transport telematic systems, wireless telecommunication technologies, are able to apply scientific research methods during the work as a electronic engineers aftre Internship. Students prepare the project documentation in conformity execution regulations. Results of the internship are publicly presented. The second part of the internship (8 CP) is anticipated for consolidating the previously obtained knowledge and improving practical skills in performing work tasks. Organization of the second part of the internship is similar to that of the first part. Results of the second part of the internship are executed in the form of a report in accordance with the instructions of the organizational unit and are publicly presented.

The Internship is organised in compliance with the Senate decision on the Procedure of the organisation of the Internship at RTU (only in Latvian). It is mentioned there, that the internship coordinator in the corresponding structural unit assists students in finding an internship placement. If additional assistance is needed, it is possible to contact the Division of Career Support and Services where a career consultant and a project manager helps students to find internship placements and to contact them, as well as implement various events to contribute to development of career management skills, which can ensure successful results in the internship process. Once a year, the Division of Career Support and Services organises the RTU Career Day, where students can meet company representatives and speak about future opportunities. See more details about the event and participants of preceding years: https://www.rtu.lv/lv/studentuserviss/karjeras-centrs-ssc/karjeras-diena. In 2021, due to the pandemic, the event took place in a virtual environment.

An additional resource developed since 2015 is a website where companies are invited to post their vacancies interesting for RTU students (https://ekarjera.rtu.lv/). Students can connect with the university username and follow current internships and employment opportunities in their industry.

The RTU Development Fund also supports promoting practical skills (https://www.rtu.lv/lv/attistibasfonds). During the year, several hundreds of competitions to improve practical skills are offered and organised in cooperation with companies and provide an opportunity for students to learn practical skills. The university enters into cooperation agreements with companies and organizations every year (see the draft of the agreement in annexed file 37 in the List of Internal Regulations), where it is agreed to provide internships for students.

Internship for foreign students is organized similar to internship for local students. Additional support is provided by International Cooperation and Foreign Students Department (ICFSD), that is involved (if necessary) in conversation between students and potential internship employers for clarification of formal requirements.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Not applicable.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The bachelor’s thesis work with a project part concludes the studies for obtaining the professional bachelor’s degree in transport electronics and telematics and qualification of an electronics engineer. The students must develop the bachelor’s thesis work with a project part (12 CP or 18 ECTS) dedicated to topical challenges and issues in the field of transport electronics and telematics. The bachelor’s thesis work with a project part must be publicly defended in front of a State Examination Commission. The commission operates in accordance with regulations approved by the University Senate.

The topics of student’s final works are selected according to the current state of the field in Latvia and in the world. For bachelor’s thesis research every student can choose the field and topic of his final thesis work with consultations from the teaching staff or select any topic offered by RTU FET TI TTES group related to research topics of the teaching staff. The goal of the bachelor's thesis work with a project part is to offer students an opportunity to develop the ability to work independently in the selected field of transport electronics and telematics. The author demonstrates that he/she is able to conduct independent research, to choose the related and necessary technologies, to perform analysis of requirements, design activities and implementation, to demonstrate the ability to develop the work in accordance with the rules of preparing scientific articles and project documentation.

Students acquire research skills through regular literature and internet resources surveys, which enables them to successfully develop bachelor's thesis work with project part. Students can present their research work at student conferences.

Examples of "Transport electronics and telematics" study programme bachelor's thesis works with a project part are provided below.

2013/2014 study year

- WiFi and WiMAX Network Performance Comparison
- Public Transport Real Motion Detection and Display
- Input and Output of Discrete Information Using Device „Raspberry Pi"
- Microcontroller Based Security System Development
- Network Simulation and Implementation using Policy-Based Routing
- Mobile LTE-WiFi Integrated Network Modernization Project Research and Development
- Development of SIP Based IP Telephony Systems
- Mobile LTE-WiFi Integrated Network Modernization Project Research and Development
- Vibration Measurement in Complex Systems
- Algorithms for Sensor Networks

2014/2015 study year

- Connection Data Loss Research in Wireless Network Depending on Number of Users
- Software Defined Network Performance Evolution
- Design of Telecommunication Equipment Devices
- 4g and Wired Internet Connection Performance and Quality Comparison in Riga
- The Development of Mobile Radio Remote Control System

2015/2016 study year

- Automotive Electronics Training Bench Design
- Passive Intermodulation Research in Mobile Network Equipment
- PEAK – Systems Technik – GPRS Link Device Research
- Development of Automatic Dependant Surveillance – Broadcast (ADS-B) Receiver
- Distance Measuring Equipment Applying for Aircraft Navigation in Airspace of the Republic of Latvia
- Universal Cable Core Number Identification Device
- Analysis of Vehicle Telemetric Data

2016/2017 study year

- Passive Intermodulation Research in Mobile Network Equipment
- Car Diagnosis with Universal Tester
- Test Bed Developing for Hyprid Wireless Network Research
- Evaluation of Microwave Communication System Parameters in the 38 GHz Range
- Application of computer vision algorithms in automation of street lighting systems

- Classification of mobile network traffic with deep neural networks

2017/2018 study year

- Openflow Based Software Defined Network Performance Evaluation
- Analysis of Automobile Dynamics Using Accelerometer and Research of Potential Usages
- Fully Automatic Night Vision Camera
- Automatoc Control System Regulation Using PLC Controller with Time-delay Compensation Method
- Creation of Wireless Sensor Networks for Energy Efficiency Improvement in Buildings
- Development of Movement and Door/Window Sensor Within a Smart Home System
- Radio Frequency Identification System

2018/2019 study year

- Developing of Routing Algorithms for Wireless Sensor Networks Using Propagation Losses
- Perspective 5G Mobile Communication Network on Railway Transport
- Performance Research of 4G/LTE Mobile Network Depending on Mobile Device Manufacturer and Weather Conditions
- Determining the Distance and Speed to the Car Ahead
- Generations comparison of home wireless access network branching systems

2019/2020 study year

- Classification of Internet calls using Machine Learning methods for network traffic processed by Wireshark
- Design of car parameter monitoring system
- Automatic Gate System
- Designing a Smart home system with a remote control function

2020/2021 study year

- Neural network security analysis in internet traffic
- ITS "Roadside" communications review and analysis of new technologies
- Network traffic classification with convolutional neural network model
- Research and use of hybrid cars to reduce exhaust emissions in the environment
- Analysis of Bentley ProjectWise and ArcGIS systems for project Rail Baltica
- Wireless sensor networks in buildings constructions
- Using Deep Neural Networks to Determine Video Traffic Quality
- Augmented reality head-mounted display power measurement and analysis
- Development of car control system monitoring equipment
- Energy efficient building options using building management system in a public building

The results of the students’ final examinations are annually discussed at the RTU FET TI TTES group meetings for bachelor’s level study programme “Transport electronics and telematics”. The results are also summarized and evaluated by management of the study programme, and they can be used for further improvements of the study process. For the review period from 2013/2014 to 2020/2021, the average grade of the final bachelor’s thesis works on the 10-points scale is 8,27.

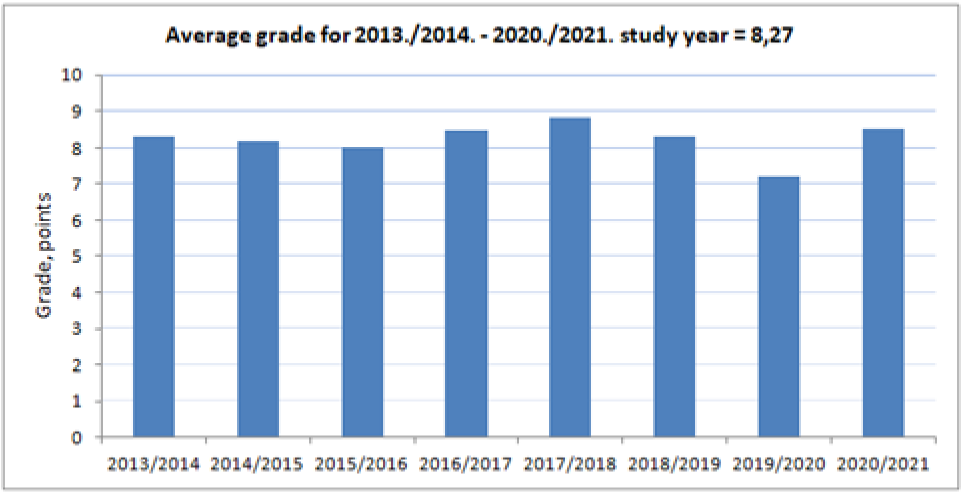


Fig. 4.: The average grade of final thesis works for professional bachelor's level study programme "Transport electronics and telematics" over duration of the review period.

The State examination commission of RTU FET TI TTES group particularly appreciates the participation of students at scientific-research activities (conferences, publications) by awarding higher grades.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

RTU have decentralized budget, therefore each structural unit has separate budget. The budget generally means a plan of incomes and expenses for a certain time period, work, event or a function. RTU incomes and expenses are administrated by the principles approved by the Senate or by the vice-rector for finances with assigned powers. Income can be of such categories, which are allocated to a structural unit for a work, for which it is responsible, for example, provision of consultations, organisation of trainings, and which are allocated to a structural unit as the result of calculations, on the basis of the volume of the planned works and/or indicators obtained in the previous periods (i.e., science support). In RTU for each structural unit, director remote access to operational financial information about the structural unit budget is provided, including the information about the planned volume of works and the corresponding financing in the next periods for implementation of the study programme and the study courses. At the beginning of each finance or budget year, the structural unit director plans the work of the structural unit, including salaries of the academic staff subordinated to the certain structural unit director and elaborating the procurement plan for the next year according to the provision of the study programme or the study course activities and development etc.

For the implementation of the study programme and achievement of the learning outcomes each year material and technical provision, as well as the study and science provision base, including printed and digital editions, are assessed.

According to the volume of the programme financing, regular renewal and improvement of resources and software are performed.

In the implementation of the programme the following material resource base is used:

- rooms (for both lectures and practical classes);
- modelling computer laboratories;
- experimental laboratories;
- methodological cabinets;
- RTU Scientific library books and periodic material storage.

There are other RTU infrastructure elements available for the needs of students and instructors - canteens and cafés, copying rooms, student hostels, RTU sport and recreation centres, swimming pools etc. In RTU rooms there are trading automates installed for buying various drinks and snacks, and drinking water is available free of charge. Information storages are regularly renewed and appended with regular and periodic leading world professional and scientific editions and books in the field.

The University library is of major importance for the implementation of the methodological and informative provision of the student. RTU Scientific library is the official state-level library, which obtained its status as a result of accreditation. The library provides all the necessary information for the RTU study process and research activities and performs library, bibliographic and information services for RTU students, academic staff, and employees. In the library collection, there are 1.4 million printed documents and e-resources in the databases corresponding to the RTU fields. Students have access to the databases, for which the RTU library is subscribed:

- **EBSCOHOST eBook Academic Collection** - eBook Academic Collection database contains ~202 200 books in various science fields: Art & Architecture; Performing Arts; Business & Economics; Computer Science; Education; Engineering & Technology; Mathematics; Life Sciences; Medicine; Philosophy; Law; Religion; History; Political Sciences etc.
- **IEEE Xplore Digital Library (IEEE/IET Electronic Library)** - IEEE Xplore Digital Library is the most extensive database packet, where all IEEE/IET full-text journals, conference materials, collections of scientific papers are available.
- **E-journal and e-book search** - with the help of SFX software it is possible to precisely define the location of an e-resource (e-journal, e-book) in the RTU Scientific Library subscribed and free access databases.
- **SpringerLink** database e-books, available are 18 500 e-books (issued within 2014 -2020) in the fields: of computer sciences; engineering sciences.
- **Web of Science** is the leading research platform of electronic resources. The unified platform provides an integrated approach for high-quality literature, it unites the search for information in bibliographic (also citation index) databases, helps find the newest and the most important scientific publications in the journals with high influence factor, collections of conference proceedings etc., as well as show citation of scientific publications.
- **Latvian standard database** content: Latvian national standards (LVS); European standards adapted to Latvian standard status (EN); International standards adapted to Latvian standard status (ISO); annexes to standards: amendments and corrections. Thematic arrangement corresponds to the internationally accepted International Classification for Standards (ICS). Standards can be searched by number and can be read.
- **EBSCOHOST -** EBSCO databases comprise periodical publications in computer sciences, engineering sciences, humanitarian and social sciences, economics, business, medicine and other fields.

- **ProQuest Ebook Central** (earlier Ebrary) database provides an opportunity to read scientific books in electronic format. In the ProQuest Ebook Central platform, a collection of electronic books «Academic Complete» is available, where about 200 000 e-books in English in PDF format are found, which were published by the world-leading scientific editions – Elsevier, Wiley, Springer, Oxford Press, Emerald etc.
- **ScienceDirect** is one of the largest databases of scientific, technical and medical articles in the world, which comprises full texts of Elsevier Science edition journals.
- **SCOPUS** (publisher Elsevier) – a bibliographic citation database of scientific literature, created by scientists for fast acquisition of information.
- **ACM Digital Library** offers high-quality publications in computer science – computer security, computer graphics, acquisition of information, mobile technologies, software development etc.
- **WILEY Online Library** database offers a packet of full text scientific reviewed journals „Full Collection".
- **Letonika** is a Latvian information and translation system on the Internet, the main objective thereof is to provide systematized encyclopaedic data and information on translation, by creating new, knowing the existing and maintaining digital resources about Latvia.
- **Learning material repository – MERLOT** The largest free access storage of learning materials in the world, which contains more than 28 000 materials and an opportunity to attach own learning materials. Here are also links to more than 500 other learning material repositories, creating unlimited opportunities for online browsing of learning material.

RTU IT provides academic and methodological work: creates and renews the study course descriptions, provides teaching of the corresponding study courses (including practical, laboratory and seminars classes), conduction of graduation works and the defence thereof and performs other activities related to academic, methodological and scientific work.

The professional bachelor's level study programme "Transport electronics and telematics" is implemented at FET building located at Āzenes street 12, in Riga. An environment matching modern requirements is located here. All audiences for the study process are equipped with multimedia devices – computers with Internet access, speakers, projectors. Thus, it is possible to ensure modern study process. Students of the "Transport electronics and telematics" study programme conduct their scientific research for bachelor's thesis works and laboratory works in one of the following RTU TI laboratories and computer classes:

- **Laboratory of Transport's Network Performance Evaluation and Radio Navigation**

In this laboratory students study three courses of the bachelor's level programme: TRT409 "Intelligent Transport Systems", TRT412 "Fundamentals of Radio Navigation", TRL534 "Computer Network Monitoring, Diagnostics and Maintenance ", as well as perform practical tasks in the study project TRT313 "Real-Time Communication Systems (study project)". Thanks to support of SIA "Mikrotīkls" in 2021, the material and technical base of the laboratory has been modernized. A powerful computer for server function role, 2 interactive whiteboards and 7 laptops have been purchased. Special gratitude to SIA "Mikrotīkls" for providing additional equipment (routers, racks, connections, mounts, etc.), which allows performing various data transmission experiments and demonstrations. The laboratory is equipped with all necessary equipment to develop transport telematic systems and perform transport network performance evaluation, modeling and analysis: Global computer network emulator Candela Technolgies WAN Emulator; Computer Network Traffic Generator Candela Technologies Traffic Generator; Computer Network Traffic Analyzer Agilent 76801A Distributed Network Analyzer; Mikrotik RouterBOARDS hAPac (IEEE 802.11ac standard); Routers Cisco 1841; Hewlett Packard Wireless Network Controller MSM720 and Access Points MSM640; Multi-channel GPS / SBAS Simulator; GNSS 72 channel GPS + GLONASS receiver, 1cm RTK accuracy.

- **Laboratory of Transport Electronics**

During the study course TRT203 “Semiconductor Devices”, in laboratory students gain practical experience in the principles of operation of semiconductor devices, as well as examine semiconductor devices in static and dynamic modes. Within the course TRT215 “Fundamentals of Circuit Theory” students learn the basics of electric circuits. The course TRT311 “Transport Telecommunication Systems” is intended to cover various types of modulation used in transport telecommunication systems. Laboratory experiments allow performing of noise-immunity evaluation for different types of modulation and provides a better understanding of transmission errors mechanism. The study course TRT226 “Analogue Devices” intendeds to acquire knowledge about operational amplifiers in the laboratory, corrections of its amplitude frequency properties, analog circuitry and power supply units. The laboratory introduces analog signal amplifiers, analog-to-digital and digital-to-analog signal converters, and also provides practical skills in circuit engineering. Practical tasks in the laboratory are performed during the work on the study projects TRT314 “Transport Microprocessor Systems” and TRL301 “Design of Telecommunication Equipment Devices”. In the laboratory students perform research on electronic vehicle control systems. A demonstration electronic control unit (ECU) is available for this purpose. By connecting it to a diagnostic device (ELM-327), it is possible to monitor real-time parameters and read diagnostic error codes. At the same time, using an oscilloscope, it is possible to monitor the signals of various sensors and, using a logic analyzer, monitor the exchange of information that takes place in the diagnostic line. Using a CAN Bus analyzer, students examine road transport data communication lines with protocols: ISO 11898-2, ISO 11898-3 and LIN V1.3 / V2.0 / 2.1. in programmable read-only memory and get acquainted with basics of telecommunication equipment design.

- **Electrical Measurements Student Laboratory**

Anticipated student training within the bachelor course RDE709 “Electrical Measurements in Telecommunications” for laboratory works and graduation paper research work in the field of voice communication service quality assessment. In the laboratory, it is anticipated to acquire skills related to electric signals, as well as service quality measuring principles in the field of electronic communications. The list of measurements includes signal voltage and level measurements, time interval measurements, study of signal frequency spectrum, attenuation measurements, as well as the acquisition of voice communication service quality assessment principles. In 2018 for improvement of the laboratory of electrical measurements the equipment for voice communication service quality control solution was procured, which is a set of hardware and software (RTU inventory No 998350).

- **Transmission Systems and Access Networks Student Laboratory**

In the transmission system laboratory students study voice signal statistics and DTFM signalling using a telephone and a virtual signal analyser; get acquainted with signal discretization in time and quantization by levels (encoding), prove theoretical limitations; get acquainted with real E1 (2 Mbit/s) PS, perform measurements of channel characteristics and transmission errors; get acquainted with modulation type basics used in PS, perform measurements and signal analysis. In the access network laboratory, within the study course “Introduction to Electronics and Telecommunications Branch” students develop practical works about important topics in the field of Electronics and Telecommunications (Internet of Things, Smart Home, sensor solutions, wireless network coverage assessment and improvement, microwave antenna solutions, voice transmission solutions).

- **Telecommunications Theory Measurement Student Laboratory**

The laboratory is anticipated for student training within the bachelor course, as well as for elaboration of laboratory works in Electrical Communication Theory, for skill improvement. In the laboratory it is anticipated to acquire skills related to principles of continuous signal discretization and regeneration, discrete modulated or manipulated signal anti-jamming ability, use of error correction code in transmission of information, as well as for transmission of electric signals for acquisition of the informative and random signal interaction principles.

- **Digital Electronics and Computer Architecture Student Laboratory**

In this laboratory classroom students acquire two bachelor study level subjects: RAE261 “Digital Electronics and Computer Architecture” and RAE701 “Digital Devices of Telecommunications Systems”. Within the framework of laboratory works students work with training schemes about such topics: recognition of logic elements, combination logic devices, triggers, registers and counters. The task is to recognise various digital logic components and to obtain descriptive logical functions thereof using truth table results. The second cycle of laboratory works is anticipated for students to acquire basic principles of programming in assembly language. Various tasks are prepared, which are related to arithmetic and data storage operations, where solution has to be presented in the form of assembly language code. The obtained solution is tested on the reprogrammable micro controller scheme.

- **Transmission Media Student Laboratory**

In this laboratory students acquire laboratory works of the subject RDE302 “Transmission Media”. The tasks to be performed in the laboratory works are related to recognition of various types of cable constructions, measurements and calculations of the primary and the secondary electrical parameters, reflectometric measurements and mutual influence parameter measurements in symmetric cables. During practical works students have to make various measurements, computations and analysis of the obtained results.

- **Class of Communication Systems and Telecommunication Networks Mathematical Modelling**

The computer classroom is equipped with 16 computers with various simulation, computation, programming and designing software (Seamcat, HTZ Communication, OptSim for Optical Communication, Matlab, Autocad, Java, Python etc). In this computer classroom students acquire bachelor study level courses: RDE711 “Mobile Network Architecture”, TRT441 “Computer Technologies in Research”, RAE202 “Computer Technologies in Telecommunications”, RAE348 “Telecommunications and Computer Networks”, TRT461 “The C Programming Language”.

During the period 2013-2022 for the needs of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science” RTU TI has acquired infrastructure for laboratories, practical classes (e.g. computer programs for modelling) and lectures (e.g. scientific literature, databases of scientific articles), computer hardware (monitors, computers, presentation lasers), laboratory equipment (ELQ-2 analyzer, GDS-1052-U oscilloscope, TLP-3c transmission error rate meter, PicoScope virtual tool, sensor signal processing and analysis devices (HW Group): Poseidon 2, STE2, WLD2, sensors (temperature, air humidity, light intensity), detectors (door contact, light flow, motion, smoke, vibration, power), Amplifi access points with amplifying antennas, NonBeam M5 microwave antennas, training kits for voice data transmission and plastic optical fiber and free space optics, etc., 11 personal computers (Capital NEO GX33 MT, LCD monitors, keyboards, mouses), microcontroller training kits (12 pcs. Arduino UNO starter kit and IoT trainer kit).

For additional convenience for RTU students, teaching staff and employees, RTU rents *Microsoft Windows, Microsoft Office* and specialised software, which provides all users with the access to the newest *Microsoft* software, and also RTU students, for learning purposes, can use RTU provided licenses for Windows operating systems and products of *Microsoft Office*. All users have access to the *Microsoft Office 365* cloud platform with one terabyte of space for data storage and access to additional shared and efficient tools (*Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook*, etc.). RTU students, teaching staff and employers have access to university e-mail services.

On all RTU premises students and teaching staff have opportunities to use a free Wi-Fi Internet access point network. The teaching staff are provided with a computer and a well-equipped workplace in classrooms - working rooms.

For all study courses, methodological materials are regularly updated and uploaded by the teaching staff in the ORTUS environment.

In addition to the compulsory part (A part), professional specialization part (B1 part), in the humanitarian and social study course part (B2 part) and the language study course part (B6 part) the following institutions are involved:

- Engineering Mathematics academic Department
- Optics Academic Department
- The Academic Department of the Theory of Probability and Mathematical Statistics
- Study department
- Labour and Civil Defence Academic Department
- Environment Protection and Heat System Academic Department
- Electronic Hardware Academic Department
- The Academic Department of Fundamentals of Electronics
- Social Science Academic Department
- Engineering Pedagogy and Psychology Academic Department
- Special Application Language Department
- Technical Translation Department

All users have access to the centralised portal ORTUS, which serves as a digital gateway uniting the data from all RTU information system components and provides users with an easy and simple user interface and easy access to the catalogues of all services in one place.

To provide effective implementation of the study process Moodle e-Learning environment is used, where all the information is prepared in an automated way (study courses, users, groups, access rights etc.). In such a system student-teacher communication is provided. The teaching staff upload to the system various electronic materials, knowledge checking tests, homework, information about each study course etc. In the ORTUS portal, students can view their financial information, and request documents (references, academic transcripts or records, copies of agreements etc.).

For effective resource management and planning of studies digitalisation of schedules and room planning is done (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Each RTU student or teaching staff can check their schedule, where it is possible to see the place of venue, the name of the teaching staff, classroom number, the name of the lecture and the type of classroom activity. For additional user convenience, the system significantly facilitates room planning and schedule preparation process and optimizes the efficiency of classroom occupancy.

For effective administrative work, electronic staff management and record-keeping systems are used, which provide record-keeping and staff document handling in RTU (https://docs.rtu.lv/). The functionality of electronic reconciliation and signature of documents is introduced thus decreasing the handling number of printed documents and significantly increasing the speed of document handling. Since the autumn of 2019 electronic signature of study, agreements are provided for the enrolling students during their applications to the study programme. Since 2016 RTU graduates can receive transcripts of records in the form of an electronically signed document.

For the provision of quality, a digital student survey system is used, which helps in controlling the quality of study courses and study programme implementation each semester. Based on the quality control results, regular measures for improvement of the study programme and processes are performed.

The total assessment of the resources is reflected in the data provided in part II Section3, criteria 3.1.-3.3. of the Study Field Report.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The source of funding for the bachelor’s level professional study programme “Transport electronics and telematics” is both the State budget and individual tuition fees.

For 2021/2022 study year admission there were 35 available places funded by the State. The tuition fee for the study programme is 1375 EUR per semester.

Table 2: Information on study programme financial resources is presented below:

Study year	Grant for the programme, EUR	Tuition fee for the programme, EUR		Total financing for the programme, EUR	Financing of one state budget seat, EUR
		Tuition fee for local students, EUR	Tuition fee for international students, EUR		
2013./2014.	86291,00	8805,00	-	95096,00	3866,00
2014./2015.	104924,30	10121,37	-	115 045,67	3866,02

2015./2016.	76995,78	1862,18	-	78 857,96	3866,02
2016./2017.	79329,46	-	-	79329,46	3866,02
2017./2018.	88761,64	-	-	88761,64	4040,66
2018./2019.	92481,25	-	-	92481,25	4229,68
2019./2020.	147558,38	-	-	147558,38	4405,04
2020./2021.	146283,79	-	-	146283,79	4462,81

The funding for one study place has increased in 2020/2021 study year by 14% in comparison with 2013/2014 study year.

RTU's funding from the state basic budget consists of study base funding corresponding to the list of study programs and the number of students, which consists of funds for utility payments, taxes, infrastructure maintenance (including providing data to the Register of Students and Graduates), the purchase of equipment and equipment, and staff salaries, as well as funding for scientific activity and business trips.

The financial resources of the study program "Transport electronics and telematics" are partly sufficient for the implementation of the study program and their use is regularly controlled both by the administration and the financial vice-rector of RTU.

The available funding is mainly used to pay for the work of teaching staff, as well as to maintain and improve the teaching infrastructure. The implementing structural unit – the Institute of Telecommunications is responsible for specific financing tasks. Funding decisions are made at the department, institute or faculty level. Significant efforts are devoted to enriching the skills and abilities of teaching staff, therefore part of the funding is devoted to paying for various courses, seminars, business trips, as well as academic vacations. Also, the investment for the addition of equipment is systematically planned.

Information on distribution of funding among cost items is available in the self-assessment report annex “Distribution of funding among cost items”.

Information on the minimum required number of students for the study programme is available in self-assessment report annex “About_the_minimal_number_of_students_in_study_programmes”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualification of the teaching staff involved into the implementation of the study programme complies with conditions and requirements of regulations. All responsible teaching staff members involved into implementation of the study programme have doctor's degree of science. All lecturers reading lectures in study courses have at least master's degrees, while practical and laboratory classes are mostly supervised by teaching staff members with master's degrees, but in some cases industry professionals with necessary practical experience are also invited.

The study programme implementation involves teaching staff of different levels and professional qualifications to fulfill the study courses of the study programme in a best possible quality. There are total of 10 professors, 6 associate professors, 14 docents, 8 lecturers and 2 researchers involved into implementation of the bachelor's study programme.

The expertise of the teaching stuff applied for the study courses complies with requirements of study programme implementation. Highly qualified scientists and industry professionals participate in implementation of the study programme. The policy of recruitment, renewal and professional development of the academic staff is based on the regular involvement of master's study programme students, master's degree graduates and doctoral study programme students in the process of studies.

The expertise of the teaching staff involved into implementation of the study programme complies with conditions and requirements of regulations and provides achievement of the goals, tasks and results for each study course and the study programme in general. CVs of all responsible teaching staff members is provided in annex (see CVs of teaching staff – P20). RTU FET TI is responsible for the study programme. Information about RTU FET TI professors and associate professors actively involved into implementation and refinement of the study programme is provided below:

Vjačeslavs Bobrovs, Dr.sc.ing., professor, senior researcher, RTU, Faculty of Electronics and Telecommunications (FET), Telecommunications Institute, Transmission Systems Group: dean of FET. Professional experience: academic and scientific work experience of more than 15 years in a higher educational institution. LZP expert in the fields of science: engineering sciences and technologies - electric equipment, electronics, information and communication technologies (fibre optics, wavelength division multiplexing, passive and active optical networks, microwave telecommunication systems, mobile networks, wireless communication systems), natural sciences - Physics and Astronomy (optical processing physics, conference, optical waveguides, lasers, optical elements, fibre optical elements), engineering sciences and technologies – nanotechnology (nanoparticles, nanophotonics, nano aerials, metaphotonics, anapole state, anapole dynamics, integrated photonics). Director of the academic bachelor's study programme "Telecommunication Technologies and Data Transmission Engineering", the academic master's study programme "Telecommunication Technologies and Networks Management", and the academic doctoral study programme "Telecommunications". Member of the P-08 Promotion Council of RTU in the field of Electric equipment, Electronics, Information and Communication Technologies, member of FET Council, RTU Scientific Council, member of the Senate and Constitution Board, member of the RTU Electronics, Information and Communication Technologies, Computer Sciences and Information Science. Member of IEEE since 2012. Co-author for 182 scientific publications available in the Scopus database, and his H-index is 13, co-author for 17 patents. Researcher or project manager in more than 15 projects in total. More than 80 bachelor papers, 85 master papers, and 7 promotion works are advised and successfully defended. Participated in ERASMUS academic staff exchange. Regularly participates in professional training and academic seminars.

Sandis Spolītis, Dr.sc.ing., professor, senior researcher, RTU, FET, Telecommunications Institute, Communication Technologies Research Centre: head of the centre. Scientific research directions: research and development of innovative fibre optics communication systems, signal processing and coding, optical frequency comb sources, radio over fibre systems, optical processing physics, optical elements and components. Published >80 scientific articles (indexed SCOPUS), 2 monographs. Co-authors of 5 Latvian patents, H-index 10. Participation in >10 international conferences with theses (verbal and stand messages). Advised and successfully defended 18 bachelor and 17 master papers, 5 promotion works (2 are defended), administration of the study courses of RTU Faculty of Electronics and Telecommunication, Institute of Telecommunications "Telecommunication systems", "Scientific workshops in the field of telecommunications" and "Scientific workshops". The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application-oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Traineeships in the Photonics Institute of the Technical University of Denmark and the Photonics Technologies Integration Centre of the Photonics Integration Institute of Eindhoven Technical University. Member of the RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies", member of the RTU Constitution Board, member of the Council of RTU Faculty of Electronics and Telecommunications, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies" and "natural sciences - Physics and Astronomy". Participation in international scientific associations – IEEE and SPIE. Reviewer of scientific articles of strong influence (Applied Sciences, IEEE Access, Micromachines, Chinese Optics Letters, Fiber and Integrated Optics, Optik, Optics Letters) and a member of international scientific conferences-FOAN, RTUWO, MTTW technical programme committee (TCP).

Ernests Pētersons, Dr.sc.ing., professor, Telematics and Transport Electronic Systems group of RTU FET Institute of Telecommunications. Directions of scientific research: the main direction of research relates to theoretical and experimental study of traffic in transport wireless networks and with practical application thereof for improving network performance. Published >60 scientific articles (indexed SCOPUS), 5 monographs, H-index 4. More than 40 bachelor and master theses, 7 promotion papers are advised, conducts the study courses of Telematics and Transport Electronic Systems group of RTU Faculty of Electronics and Telecommunications Telecommunication Institute "Computer Networks", "Information Compression and Encoding Theory", "Cryptography and Data Security Technologies", "Network Analysis and Design", "Communication in Transport Intellectual Systems", "Real-Time Communication Systems", "Communication System Models". Active participation in other educational institutions in Latvia by reviewing promotion papers, including the LU Institute of Mathematics and Computer Science. In total, by working in various state educational institutions in Latvia he prepared 22 highly qualified specialists with a doctor's degrees. The experience of project manager and executor in various state and internationally financed scientific research projects – RTU scientific research platform project, State research programme and ESF projects. Practical scientific cooperation within the last years has been with the prof. Aļģimantas Kajackas from Vilnius Technical University and the prof. Vladimir Vishnevsky from the Management Problem Institute of the Russian Academy of Sciences. A member of RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies" (in the last six years 6 promotion papers are reviewed), a member of RTU Faculty of Electronics and Telecommunications Council, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies-Electric Equipment, Electronics, Information and Communication Technologies. Participation in international scientific associations – IEEE. A member and reviewer of the editorial board of the journal Automatic Control and Computer Sciences. Appreciations:

Emeritus prof. honoured title, several appreciations for preparation of highly qualified specialists, and honoured Lifetime IEEE membership.

Aleksandrs Ipatovs, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Telecommunications Institute, Head of Telematics and Transport Electronic Systems Group. Scientific research fields: elaboration and research of Telematics and Transport Electronic Systems, Signal Processing and Encoding, Wireless Networks, Computer Network Traffic Analysis, Assessment of Computer Network Performance. Published >26 scientific articles (indexed in SCOPUS). H-index 4. Participation in >10 international conferences with theses (verbal and stand messages). 10 bachelor papers, 3 master papers and 4 promotion papers are advised. Implemented study courses "Fundamentals of Computer Architecture", "Transport Real-Time System Maintenance", "Management of Intellectual Transport System", "Introduction to Computers and Algorithms", "Computer Technologies in Research", "Network Databases and Data banks". The experience of project manager and executor in various state and internationally financed scientific research projects – ERDF post-doctoral research project (PostDoc), ERDF Application oriented research projects, RTU scientific research platform project, State research programme and ESF projects. Member of the RTU Promotion Council RTU P-08 "Electric equipment, Electronics, Information and Communication Technologies" (1 promotion paper reviewed), member of the RTU Constitution Board, member of the Council of RTU FET, member of RTU Council of professors of Information and Communication Technologies, Computer Sciences and Information Science, Latvian Council of Science expert in the fields of "Engineering Sciences and Technologies - Electric Equipment, Electronics, Information and Communication Technologies". Participation in international scientific associations – IEEE and SPIE. A reviewer of international high influence scientific journal articles and a member of the technical programme committee (TCP) of the international scientific conferences - RTUWO, MTTW.

Andis Supe, Dr.sc.ing., associated professor, senior researcher, RTU, FET, Telecommunications Institute, Telecommunication Network Group. Large scientific work experience in the field of fibre optical transmission systems. Participated in the successful implementation of many European Regional Development Fund (ERDF) and European Social Fund (ESF) projects and Latvian National Research Programme. In the period from 2018 until 2020, A. Supe implemented the post-doctoral project "RETUNE", which focused on signal regeneration using non-linear optical effects. During the implementation period of the post-doctoral project, international research work experience was obtained at the Institute of Telecommunications of Aveiro University. A. Supe is a co-author of more than 30 international publications (Scopus data), co-author of 6 Latvian Patents and a member of the international IEEE conference MTTW TCP. He is involved in Latvian Council of Science as an expert in electronics and telecommunications. A. Supe has more than 8 years of academic work experience teaching subjects at bachelor, master and doctoral levels. 23 bachelor papers and 16 master papers are advised and defended.

Elans Grabs, Dr.sc.ing, docent, senior researcher, RTU, FET, Telecommunications Institute, Telematics and Transport Electronic Systems Group. Scientific research fields: digital signal processing, traffic of computer networks, machine learning, digital telecommunications. 17 scientific publications (Scopus database), H-index: 3. Participated in several European Regional Development Fund (ERDF) projects and Latvian State Research Programme project implementation. During post-doctoral research promoted international research experience at Johannes Kepler University in Austria. Supervising multiple bachelor's and master's thesis works.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

The implementation of the study programme involves both academic staff and highly qualified professionals of the field to fulfil the study courses included in the study programme with the best quality possible.

The study programme implementation involves 10 professors, 6 associate professors, 14 docents and 8 lecturers. Professors and associate professors are Doctors of Science with scientific and pedagogical qualification complying with the criteria defined by regulations on professor's position candidate scientific and pedagogical qualification evaluation.

The analysis of the changes revealed several reasons of such changes:

1. Associate professors and docents have improved their qualification during the review period and were promoted to professors or associate professors;
2. Some of the teaching staff has participated in grant competitions and received funding to conduct research in the field, thus changing their academic position to senior researcher position;
3. New professionals of the field have been hired promoting introduction of new technologies to study courses, therefore new lecturers and assistants were invited to implementation of the study programme;
4. Part of the academic staff have retired.

The weighted average age of academic staff in almost all groups have decreased. These changes are reflected in the table below.

Table 3: Changes of the teaching staff involved in the programme courses

2011/2012			**2020/2021**		
	Number	Average age		Number	Average age
Professor	9	68,2	Professor	10	62,2
Assoc. Professor	4	63	Assoc. Professor	6	42,8
Docent	10	52,2	Docent	14	45,6
Lecturer	6	34,5	Lecturer	8	36
Researcher	-	-	Researcher	2	35
Total	29		Total	45	

In the implementation of the study programme new qualified teaching staff is involved, thus moving the content of the study programme closer and closer to the specifics and the relevant topics of the field.

The policy of recruitment, renewal and professional development of the academic staff is based on the regular involvement of master's level students, master's degree graduates and doctoral level students in the process of studies. Currently, there are 7 lecturers studying at PhD level programme, which promotes introduction of new teaching techniques and link between study process and their scientific research.

Currently, RTU implements the European Social Fund financed project SAM 8.2.2. “Strengthening of Riga Technical University academic staff in strategic specialisation fields”, where one of the tasks is the renewal of the academic staff. The objective of the project is to strengthen RTU academic staff in strategic specialisation fields in 10 study directions. The project activities are in three directions:

- involvement of doctoral students in RTU academic work;
- attraction of foreign academic staff to RTU;
- improvement of expertise for the existing academic staff, including traineeships of the academic staff in companies.

During the project, it is also possible for the academic staff to take professional English language courses and specialised courses.

The academic staff is stable and regularly participates in various events related to the improvement of expertise. Improvement of expertise is achieved by the academic staff through participation in academic and scientific conferences and seminars, and acquisition of various courses. The findings obtained during the improvement of expertise and during the scientific work are introduced into the study process.

The teaching staff of the study programme participates in local and international conferences, which is reflected in the curricula vitae of the teaching staff.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying

the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The cooperation of the teaching staff members begins with the planning of the academic year and coordination of the study course project tasks during regular methodological seminars and continues over duration entire semester duration by teaching study courses and planning all the necessary improvements for the next semester at the level of entire study programme.

Each year the study courses of the programme are regularly improved, based on both - recommendations from students and trends of the field. During the study courses, regular meetings and methodological seminars of the teaching staff are held, where experience exchange about study course topics take place, and the content of study courses is developed and improved through mutual agreement on topics, directions, responsibilities and correspondence to the regulatory requirements. In the process, of course, reconciliation all members of the teaching staff are involved, who are involved in the implementation of a certain study course, providing that the topics included in the study programme are continuously being improved and renewed in cooperation with the professionals working in the field.

In planning and including new study courses into the study programme it is mutually reconciled that study courses do not overlap and provide students with the necessary knowledge in each field. When reviewing and actualising the study programme, the teaching staff agrees on the most applicable and efficient solutions with respect to the assessment of students achievements and the acquisition of results. When planning a study year and making an agreement on project tasks of the study courses, the disadvantages found before are taken into account and corrections are introduced.

When analysing the ratio of students to teachers in the study programme, at the time of submission of self-assessment there are 2 students for one elected member of the teaching staff and for 6 students - one specialist of the field.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_ECT0(42523)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_ECT0(42523)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_ECT0(42523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_ECT0(42523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_ECT0(42523)_CompliancewiththeStateEducationStandard_ProfBak_ENG.pdf	P06_3.2.1_ECT0(42523)_AtbilstibaValstsStandartam_ProfBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_ECT0(42523)_ComplProfStand_ENG.pdf	P07_3.2.1_ECT0(42523)_AtbProfStand_LV.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_ECT0(42523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_ECT0(42523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_ECT0(42523)_Plans_lv_Plan_eng.pdf	P09_3.2.1_ECT0(42523)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_ECT0(42523)_StudyCoursesdescr_ENG.zip	P10_ECT0(42523)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_ECT0(42523)_InternshipManagem_ENG.docx	P31_ECT0(42523)_PraksesOrganiz_LV.docx
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Computer Science and Organizational Technologies (43483)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Science and Organizational Technologies*
Education classification code	*43483*
Type of the study programme	*Academic bachelor study programme*
Name of the study programme director	*Jānis*
Surname of the study programme director	*Grēviņš*
E-mail of the study programme director	*janis.grevins@rbs.lv*
Title of the study programme director	*PhD*
Phone of the study programme director	*+371 6708900*
Goal of the study programme	*The study program aims to provide students with the theoretical knowledge and research skills in the field of computer science, which is based on theoretical principles in the fields of information technology and computer science; to educate and train innovative-minded specialists focused on the introduction of new technologies and knowledge, as well as to ensure a set of knowledge, skills, and competences in accordance with the 6th level of the Latvian Qualifications Framework.*
Tasks of the study programme	*Tasks of the study program:* *1. To ensure students' ability to apply program technologies, programming methods, and technologies;* *2. To provide students with an understanding of organizations' activities, service provision, and product manufacturing processes, as well as human resource management;* *3. To ensure students' understanding of the legal, ethical, social, and economic context and its international development;* *4. To provide students' skills in teamwork, and communication internationally and with specialists in different fields;* *5. To provide students with knowledge, skills, and attitudes for successful and efficient management of technology projects.*

Results of the study programme	*Learning outcomes of the study program:* *1. To explain the theoretical foundations of computer science, including the essence of algorithmization, data structures, discrete mathematics, system theory, and computer architecture;* *2. To participate in the development of computer systems of companies and organizations, including computer networking and development of databases and software;* *3. To identify the role and capabilities of computer technology in the organization's operations, service provision, and product manufacturing processes, as well as human resource management;* *4. To assess the necessity and suitability of computer solutions for various organizational challenges;* *5. To observe and explain the legal, ethical, social, and economic principles adopted in professional practice in computer science;* *6. To participate in teamwork organization, to communicate internationally and with specialists in different fields;* *7. To plan and coordinate projects successfully and efficiently;* *8. To communicate with the customers of information technology solutions and analyze the possibilities of using information technology;* *9. To implement research in the fields of computer sciences and organizations;* *10. To be aware of developments in the field in order to participate effectively in lifelong learning.*
Final examination upon the completion of the study programme	*Bachelor Thesis*

Study programme forms

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Bachelor of Natural Sciences degree in Computer Control and Computer Science*
Qualification to be obtained (in english)	—

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

During the accreditation period, changes have been made to improve the quality of the study program based on current developments in the sector, employers' and students' recommendations:

1. The list of study program courses has been updated by including the following study courses based on the experience with regard to the implementation of the study programs at the partner universities (the University at Buffalo and BI Norwegian Business School) (Table 1)
2. The study courses transferred from one part to another part (Table 2)
3. Compulsory elective study courses (Part B) have been archived based on the experience of the partner universities (the University at Buffalo and BI Norwegian Business School) (Table 3)
4. The free elective study courses (Part C) have been removed from the program, due to the fact that there is no need to provide additional courses for the foreign students within the program, as the study course "Latvian for Foreign Students" (VIL168) will be offered (Table 4)

The changes made have allowed updating the content of the courses to the latest trends, thus offering students an insight into the industry and providing knowledge from a variety of sources. Upon graduation, students are competent and confident in their future career choices.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The academic Bachelor study program "Computer Science and Organizational Technologies" has been developed taking into account RTU strategic goals, market supply and potential demand. See Annex P06 for the compliance of the study program with the state education standard.

The scope of the study program is 160 CP and the duration of implementation is 4 years. Such duration and scope of the program allows to cover the necessary skills of the new specialists and allows the new IT field and organization management specialists to successfully start their careers in the specialty, which is especially important, taking into account the demand for IT specialists with organizational management skills in the Latvian IT industry.

The study program most directly corresponds to the field of study "Information technologies, computer engineering, electronics, telecommunications, computer management and computer science", because the content of the study program focuses on software engineering and includes knowledge and skills corresponding to information technology, computer science and partly also computer engineering and computer management, in addition including organizational management skills.

The computer systems study program classification code 43483 – Computer systems, databases, and computer networks have been chosen because the purpose and content of the program are related to the acquisition of theoretical and practical skills in the field of computer science, as well as to prepare young specialists with innovative thinking and the realization of ideas in practical application.

Acquisition of skills and knowledge within the study program is ensured by the European and world-class academic and scientific staff. Innovative study methods – more practical knowledge and the use of modern technologies – are used in the implementation of the study program.

The aims of the study program are to provide students with the theoretical knowledge and research skills in the field of computer science, which is based on theoretical principles in the fields of information technology and computer science; to educate and train innovative-minded specialists focused on the introduction of new technologies and knowledge, as well as to ensure a set of knowledge, skills, and competences in accordance with the 6th level of the Latvian Qualifications Framework. The aims and tasks of the study program are formulated based on surveys about the wishes and requirements of the interested parties (potential employers, universities, students, society, and scientific institutions) towards the graduate.

Tasks of the study program:

1. To ensure students' ability to apply program technologies, programming methods, and technologies;
2. To provide students with understanding of organizations' activities, service provision, and product manufacturing processes, as well as human resource management;
3. To ensure students' understanding of the legal, ethical, social, and economic context and its international development;
4. To provide students' skills in teamwork, communication internationally and with specialists in different fields;
5. To provide students with knowledge, skills, and attitudes for successful and efficient management of technology projects.

Learning outcomes of the study program:

1. To explain the theoretical foundations of computer science, including the essence of algorithmization, data structures, discrete mathematics, system theory, and computer architecture;
2. To participate in the development of computer systems of companies and organizations, including computer networking and development of databases and software;
3. To identify the role and capabilities of computer technology in the organization's operations, service provision, and product manufacturing processes, as well as human resource management;
4. To assess the necessity and suitability of computer solutions for various organizational challenges;
5. To observe and explain the legal, ethical, social, and economic principles adopted in professional practice in computer science;
6. To participate in teamwork organization, to communicate internationally and with specialists

in different fields;
7. To plan and coordinate projects successfully and efficiently;
8. To communicate with the customers of information technology solutions and analyze the possibilities of using information technology;
9. To implement research in the fields of computer sciences and organizations;
10. To be aware of developments in the field in order to participate effectively in lifelong learning.

Applicants with general or vocational secondary education are admitted to the program. Admission is based on 3 criteria with the equivalent weight:

- Percentage scores of Centralized Examination (CE) in Mathematics, Foreign Language (English), the Latvian Language, Physics, or Chemistry are summed up and the resulting number is multiplied by 0.25;

CE in Physics or Chemistry is taken into account in calculating rank if the CE has been passed.

- International English proficiency test score taken within the last 2 (two) years multiplied by 0.25;

- TOEFL (Test of English as Foreign Language) paper-based test (test score divided by 677 and multiplied by 100);

- TOEFL (Test of English as Foreign Language), Internet-based tests (RBS TOEFL code 7227);

- IELTS (International English Language Testing System) test (test score divided by 9 and multiplied by 100);

- The scores obtained in the selection interviews (structured interview) are summed up, and the resulting number is multiplied by 0.5;

All the criteria are summed up according to the weighting factors to rank the applicants. The admission requirements of the study program are set in accordance with the Enrolment Requirements for Academic and Professional Undergraduate Study Programs approved by RTU Senate.

The BITL program corresponds to two fields – computer science and management science. The degree and the learning outcomes correspond to these fields. The admission rules define uniform admission criteria, thus ensuring that all students are equally able to enter the program. All instructors hold industry-relevant degrees in computer science, information technology, management, finance, or mathematics.

After obtaining the degree, students are entitled to continue their studies at academic Master study programs, professional study programs designed for holders of the academic Bachelor degree, and professional Master study programs if additional requirements are fulfilled.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

Europe’s competitiveness, innovation, and job creation increasingly rely on information and communication technologies (ICT).

Effective ICT professionals at mid-and senior levels need both technical expertise and a broad range of knowledge in other fields related to and/or using technology solutions and good communication, teamwork, and project management skills.

The world's leading ICT professional bodies (Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE), Association for Information Systems (AIS), International Federation for Information Processing (IFIP), British Computer Society (BCS)) have incorporated these requirements into their study program curriculum guidelines and accreditation standards[1]. For this reason, a need was identified to develop an interdisciplinary ICT study program in Latvia, which would include not only ICT courses, but would also cover other academic areas, the knowledge of which would provide graduates with the skills to effectively integrate ICT solutions in different organizational environments.

The study program has been independently assessed by the Latvian Information and Communications Technology Association, the Finance Latvia Association, the Ministry of Economics, as well as Accenture Latvia. To ensure the compliance of the program with the needs of the industry, employers, representatives of Latvian and foreign professional organizations are involved in the supervision and implementation of the study program.

The first graduation ceremony for students majoring in Computer Science and Organizational Technologies is planned for June 2023.

Employment prospects and forecasts for graduates

The Latvian labor market is in high demand for young IT professionals – there are currently around 550 graduates from higher education institutions in the IT sector each academic year, but the number of graduates should at least double to meet labor market demand. In addition, the need for middle and senior level computer science managers with a broader range of social and managerial skills is becoming increasingly apparent in the labor market.

Given these requirements, it is expected that graduates of the program will be in high demand on the Latvian labor market and will be able to find a job easily. Graduates of the program are expected to be able to work as:

- Computer and Information Systems Managers
- Computer Systems Analysts
- Information Security Analysts
- Computer Programmers
- Software Developers
- Web Developers
- Network and Computer Systems Administrators
- Computer User Support Specialists
- Computer Network Support Specialists
- Organization Technology Planners.

[1] https://www.acm.org/binaries/content/assets/education/curricula-recommendations/csec2017.pdf

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

During the reporting period, the number of enrolled and newly admitted students in the study program has varied. The COVID-19 pandemic had a major impact on the number of admitted students, limiting the achievement of previously planned admission. The number of admitted students has fluctuated in the range of 20-30 students, but the program has only been running for 3 years, and the aim is to increase this number each year.

The program offers only tuition fee-covered seats, with no state budget-funded seats. All students study in English.

Figure 1 (annex 5) illustrates the dynamics of the number of admitted students in the period from 2019 to 2021.

The number of students enrolled in the program increases every year (see Figure 2) (annex 5).

Figure 2 shows that the smallest number of students was in 2019 when the program was launched, as time was a limiting factor between the licensing of the program and the start of studies. In the following two years, there has been an increase in the number of students, which can be explained by the quality of the content, which creates good publicity for the study program. The figure shows that the number of students has increased, but the number of admitted students has decreased due to Covid-19 restrictions and the subsequent reduction in the possibilities to promote the program, and there has been the very limited promotion of the program at the international level.

Students drop out from the program for various reasons. Despite the involvement of the head of the program, individual interviews and the provision of motivation, there is still a small number of students who decide to leave their studies on their own free will, often due to changes in career goals or interests. Figure 3 (annex 5) shows the reasons for drop out.

The number of expelled students varies in the range of 5-10%, which does not significantly impact the implementation of the study program. Figure 4 (annex 5) shows the expulsion rate.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the

relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

During the reporting period, changes in the aims, tasks, learning outcomes to be achieved, and curriculum have been deliberately made, responding to the current situation in the labor market to keep up with the scientific innovations. Current industry trends are included in the course content.

The head of the study program ensures the correspondence of the changes in the BITL program to the changes in the aims, tasks, and learning outcomes of the study field; the course content is updated and improved, taking into account the contemporary scientific literature and other resources, as well as the latest research trends. The interdisciplinary perspective is updated in the provision of content, building students' transversal competencies.

The curriculum of the study program is made up of several blocks: fundamentals of ICT, mathematics, and statistics, field-specific study courses, general courses, additional field-specific study courses, free elective study courses and a graduation paper.

The courses on ICT fundamentals provide knowledge and skills in the basics of computer science and give an insight into algorithm design, artificial intelligence, software and information systems, computer hardware, and network systems. After acquiring the basic ICT skills, students have a broad enough background to be able to choose their specialization successfully.

Study courses in mathematics and statistics aim to provide students with the necessary knowledge and skills to succeed in other courses. Two courses in calculus and one in statistics make up this block of courses.

Within the field-specific study courses, the student has to choose to either specialize in Computer Science – Artificial Intelligence and Data Representation –, or in Management – General Management.

The compulsory and compulsory elective courses aim at giving students a broader perspective than ICT courses alone. They develop students' social skills needed to be able to work and manage teams successfully, as well as to work with professionals from other fields. Students can choose between courses in communication and writing, economics, innovation, foreign languages, and history.

Free elective study courses give students the freedom to choose the courses of their preference, allowing them to gain additional knowledge in an area of their interest.

The BITL program consists of compulsory Part (A), which includes the core compulsory courses in the field; compulsory elective part (B), which consists of a variety of courses in the field; and free elective Part (C). The Bachelor Paper is an essential part of the studies. The total volume of courses is 160 CP. The study plan is provided in Annex P09.

The Bachelor study program focuses on providing a balanced study load throughout the semester and among the different elements of the study process. The final assessment of a student's knowledge consists of at least four components: group work and individual work, engagement during the course (attendance/active participation in discussions), and examination. This assessment structure allows students to gain practical experience in problem-solving and to learn how to work in a team, solve individual problems and defend their position in discussions. Taking into account the aim of the program – to educate and train professionals who are able to effectively communicate with senior management, colleagues, and subordinates – the program places a strong emphasis on group work, during which students are required to make presentations in teams and defend their views.

Taking into account Latvia's integration into the world economic system and the globalization of business, the language of instruction is English, which facilitates students' acquisition of terminology in international business and information technology.

The program places increasing emphasis on the use of the latest scientific publications and their electronic analogs in the learning process. At the end of the program, students are required to develop the Bachelor Paper in which they apply the latest scientific knowledge to research and propose solutions to specific information technology and computer science problems.

The content of the study courses, the results to be achieved, and the set goals are agreed upon and followed by the common goals and the results to be achieved of the study program. These issues are regularly discussed at the meetings of the Advisory Board, respecting current events in the industry and the labor market. Detailed information on the relationship between study courses and programs can be found in Appendix P08 (study mapping).

The appropriateness of the content of the study courses is discussed at the meetings of the Advisory Board, in addition, it is taken into account the recommendations of the Alumni Association, the recommendations of employers, as well as the students themselves, and the issues raised. Since several professors are also internationally recognized researchers, as well as experts of the Latvian Science Council, this contributes to the integration of the latest scientific knowledge in the study process and methodological provision.

3.2.2. In the case of master's and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

In order to ensure the logical acquisition of the study courses, the RBS study portal ORTUS has integrated functionality that allows a student to register only for those study courses for which they have completed the required introductory courses.

The main procedures to ensure the quality and continuity of studies are as follows:

- the possibility for students to register independently for compulsory elective and free elective study courses on the portal (ORTUS);

- the availability of lecture materials and resources for students on the RBS study portal;

- the provision of up-to-date teaching materials and a system for assessing the quality of studies.

The aims of the study courses ensure balanced achievement of the aims of the study program, thus providing students with the knowledge of all current issues in information technology and computer science. A detailed overview of the interrelationship between the aims of the study courses and the aims of the study program is provided in Annex P08, "Mapping of the Study Courses of the Academic Bachelor Study Program "Computer Science and Organizational Technologies"'.

Both oral and written, as well as combined study and assessment methods, are used during the tests and examinations within the study program.

The assessment of learning outcomes obtained within the study courses of the program is performed in accordance with RTU Regulation on the Assessment of Learning Outcomes. RTU follows the following basic principles of assessment:

- the principle of openness of assessment – in accordance with the set program aims and tasks, as well as the aims and tasks of the study courses, a set of requirements for the assessment of the learning outcomes is defined;

- the principle of compulsory assessment – it is necessary to obtain a positive assessment attesting the acquisition of the entire program contents;

- the principle of the possibility of assessment improvement – the university shall set up the procedure for improvement of the assessment obtained;

- the principle of a variety of assessment methods – different types of assessment are used to assess the knowledge acquired within the framework of the study program.

During the final examination, students demonstrate their knowledge, skills, and competencies according to the specificities and requirements of each study course. The students should demonstrate that they are able to apply in practice the skills and knowledge acquired within a particular course, understand their context, meaning, and practical applicability; present the results of scientific research conducted independently or in a group; demonstrate critical thinking and effective communication skills, the ability to solve complex problems; to apply the acquired knowledge and methods learned.

Depending on the specifics of the study courses within the Bachelor study program, the final examination takes different forms: written form (tests, examination questions), presentation, scientific research (essay) and discussion, or practical scientific research.

The acquisition of study courses is evaluated on the basis of criteria defined by the regulations: the amount and quality of the knowledge acquired; the skills developed; the competencies acquired in accordance with the envisaged learning outcomes.

At the final examination, the student must demonstrate:

Knowledge:

- Be familiar with the technologies, research methods, literature, and other sources used in the field;

- Be aware of the structure of academic papers and the methods of writing and developing them;

- Be aware of the formal requirements of RTU for the development, submission, and presentation of graduation papers.

Skills:

- Identify the topic and research problem of their research paper, clearly formulate the aims and tasks of the research, and substantiate the thesis statements and conclusions of their research;

- Meaningfully discuss the research findings with other students, lecturers, and the scientific adviser;

- Present their research to an audience concisely and effectively.

Competences:

- Carry out independent research in the field;

- Present research findings in writing in an academic style and format the research paper appropriately to the discipline (including proper citation and references);

- Critically and/or constructively evaluate other researchers' (students') research papers (or parts of them) and presentations.

Throughout the study process, great emphasis is placed on the basic principles of student-centered education. How, for example, during the learning process, students' abilities are assessed in different subjects. Students who clearly need more attention are offered both additional laboratory lecture times and special consultation times. In addition, during the curriculum, various ways of learning material are applied - such as guest lectures, video materials, various visual materials, stories of experiences, presentations, etc.

During the learning process, students are encouraged to be independent by writing and researching various publications and creating reports and presentations. The process is supervised by a faculty member, who provides support and guidance when necessary.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Not applicable, as the first defense of the bachelor's thesis will take place in 2023.

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process takes place at the RBS premises located at Skolas Str. 11, Riga. They are equipped with modern equipment and facilities. In total, one large lecture room with a seating capacity of up to 98 people, four medium lecture rooms with a capacity of 45–70 people, and seven small lecture rooms with a capacity of 12–35 people are available for the needs of the study process.

Classrooms have been upgraded to support a blended-mode learning experience for academic staff and students, which has been particularly important due to the constraints caused by COVID-19. Each classroom is equipped with a 65-inch Samsung Flip 2 digital whiteboard, which is integrated into the Zoom platform as a shared screen. The whiteboard and presentations are also mirrored on a 55-inch TV so that students can see the shared screen in high quality from anywhere in the classroom. A third 55-inch TV has been installed in the classroom, allowing up to forty-nine students to be presented online at the same time on a single screen. The classroom computers have i7 processors so that the videoconferencing screen-sharing function can be used for teaching applications without affecting their performance.

Each classroom is equipped with a wireless microphone system, “Catchbox Plus.” The system includes one audience microphone and a presenter microphone that can be used for meetings, lectures, and events. The throwable microphone has a built-in automatic sound cancellation function. Both microphones have a range of up to 100 m with a 12 h battery life.

Live video is provided by two C920S PRO HD cameras. One of the cameras projects the lecturer in the classroom, and the other camera captures the students in the classroom. The technical support of the classrooms is suitable for the lecturer to conduct the lecture from anywhere in the world so that the lectures can be delivered from both Europe and America.

The specialized library and computer laboratory are available for students.

In order to intensify the teaching process, continuous access to RTU unified study support system ORTUS, which is based on Moodle, has been provided during the reporting period. At the moment, ORTUS provides students with:

- Posting of lecture handouts and presentations;

- The documents regulating the learning process and their changes;

- Instructors’ CVs;

- Remote authorization of students for commercial electronic information tools (databases);

- Information on student performance;

- Information on the student’s financial situation, with the possibility of electronic invoicing;

- Real-time registration/de-registration for the following semester;

- Student enrolment in distance or hybrid learning;

- Possibility of taking remote examinations.

In addition to these services, ORTUS provides tutor/student communication within the course, electronic processing of homework and tests, and other services in a modern study environment.

RBS has established cooperation with international publishing houses, distributors of business case studies, and maintainers of electronic databases in order to provide RBS students with the latest study literature.

Cooperation with international publishers has ensured that RBS students have access to and use the latest textbooks in all study courses. To ensure this, access to books in electronic format is primarily organized for students. Interactive textbook platforms such as Pearson’s MyLab and Mastering, Wiley’s WileyPLUS, Cengage’s MindTap, and WebAssign, among others, are made available to make the learning process more interactive and complete. Textbooks and their interactive platforms, if used, are reviewed before the start of each course of study to ensure a more appropriate choice of learning resources for both the instructor and students.

To provide RBS students with case studies, RBS has partnered with the Case Centre and Harvard Business Publishing (HBS). The agreement with HBS Publishing for access to the publishing house’s teaching materials and related instructor’s guides allows expanding the range of situation analysis materials to be studied and reducing the cost of purchasing them, thus ensuring active and professional use of business situation analysis materials in the RBS study process. Beyond the textbooks and case study materials used in specific courses of study, RBS students have access to a concentrated collection of physical editions that provide basic literature in economics, business management, marketing, entrepreneurship, and financial management and analysis.

Students are provided with access to subscribed databases and other electronic resources for conducting independent research, and getting to know the latest industry research and other electronic resources.

During the reporting period, intensive efforts have been made to provide RBS students with access to electronic resources necessary for the learning process. During the reporting period, RBS students and academic staff have been provided with access to the following resources: IEEE Xplore Digital Library (IEEE/IET Electronic Library), SpringerLink, Web of Science, Latvian Standards Database, ProQuest Ebook Central, ScienceDirect, SCOPUS, ACM Digital Library, WILEY Online Library, LETA, Letonika, MERLOT, Directory of Open Access Journals (DOAJ) and several EBSCOHOST collections and databases, especially EBSCO eBook Academic Collection and EBSCO Business Source Ultimate. Trial access to various e-resources is regularly provided to assess the need for other/additional resources. To facilitate the search and research process, access is provided to the

PRIMO search engine, which allows searches to be carried out in several subscribed databases and collections simultaneously.

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

The study program is fully funded by student tuition fees. Students can apply for bank loans and various scholarships to pay the tuition fees. Due to inflation and the need for continuous development of the program, tuition fees are increased every year.

At the early phase of the program, technical and infrastructural support was provided by the industry and existing resources from RBS and the Faculty of Computer Science and Information Technology. Surplus income from the operational costs of the program will be invested in the academic and scientific capacity building of the program staff, as well as in general and infrastructure development.

The auditorium of the program was wholly renovated with computers for the funds of study fees, thus facilitating the planning of the study process. In addition, with the onset of COVID restrictions, remote learning became relevant, so the following equipment was purchased: 7 digital whiteboards, including stands and mounts; 7 additional TV screens; 20 video cameras and three 360 ° video cameras; seven sets with wireless microphone system "Catchbox plus". In addition, a smart audience management system was also installed.

Table 5 provides the current financial information for the first two years of program implementation and the projected financial information for the next 4 years. The average cost per student is EUR 3000 per year. The costs per student include staff remuneration expenses, which constitute 75% of the total direct costs, teaching materials, which constitute on average 9.8% of the direct costs, program administration, which constitutes on average 9.5% of the direct costs, marketing costs, which make up on average 4.6% of the direct costs and other costs, which represent on average 4% of the total direct academic costs.

The minimum number of students in the program to be cost-effective is 100 students per program. This means that a minimum of 25 students per year need to be enrolled in the program each year.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The study program is implemented by the instructors of RBS, the Faculty of Computer Science and Information Technology, and the Faculty of Computing. In total, 33 academic staff members are involved in the implementation of the Bachelor study program “Computer Science and Organizational Technologies.” The CVs of all academic staff members involved in the program are provided in Annex P20. Figure 6 shows the percentage distribution of RBS academic staff positions.

14 instructors holding a PhD degree and 18 instructors holding a Master degree participate in the implementation of the study program. Figure 7 shows the proportional distribution of education acquired by the academic staff. Among them, there are also professionals in the business sphere, such as board members, executives, and founders representing various institutions. The experience of the academic staff allows students to get to know the labor market and its challenges from a practical point of view.

The study program is primarily implemented by the instructors of RBS, the University of Latvia, and the RTU Faculty of Computer Science and Information Technology. Guest lecturers from foreign universities are also invited, industry specialists are also attracted to deliver practice-oriented study courses. In line with the mission of the program, the primary criteria for the selection of academic staff are as follows:

- Knowledge of the latest developments in their field;
- Pedagogical and didactical skills in the field, in line with the current trends;
- English language skills;
- International experience and experience of studying or teaching at interdisciplinary programs.

The program also involves academic staff members who deliver study courses within RBS academic Bachelor study program “Management in International Business”; these courses are also attended by students of the program under consideration. It ensures a high level of teaching of management and general education courses, which complies with the interdisciplinary aim of the program.

At the end of each semester, RBS students are required to complete a course evaluation questionnaire, which allows both the instructor and the administration to draw conclusions and plan any necessary improvements to the course. Five surveys we conducted in the period 2019–2021. The results are shown in Figure 8.

As Figure 8 shows, students are highly satisfied with the performance of the academic staff as well as with the knowledge acquired. Students appreciate the time invested by instructors, their responsiveness, the feedback given, and the teaching style. Moreover, it is evident that the constraints imposed by COVID have not affected students’ satisfaction with the quality of the

courses.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

In order to keep the program up-to-date, the composition of the academic staff has changed during the reporting period. The trend of attracting new instructors, including PhD students in computer science and management, will continue. Potential academic staff members who have demonstrated themselves as outstanding researchers and professionals in their field are regularly approached. As an example of good practice, Kārlis Berkolds (study course “Computer Organization”), Kārlis Atrens (study course “STEM Communication”), and Jānis Lazovskis (study course “Introduction to Linear Algebra”) are young teachers with international educational and professional experience who, in collaboration with the University at Buffalo where they have been educated and trained, have developed their first courses for the program.

The involvement of professionals from the field of computer science and the business sector is also essential. The course “The Firm” delivered by Marta Jaksona may be given as an example; it has been highly appreciated by students. The attraction of foreign lecturers plays an important role in promoting internationalization, and the lectures delivered by the internationally renowned lecturer Arthur Michael Wells (UK) are an example of good practice.

The renewal of the academic staff has led to improvements in this respect:

- The content of the study program has been improved, adapting it to the needs of the sector;
- The development, application, and implementation of e-solutions in the study process have been improved;
- Innovative teaching methods have been introduced.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying

the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The academic staff of the BITL program cooperates with each other by developing descriptions of study courses and participating in projects. In-service training activities, such as trainings on LinkedIn and the DigiExam exam platform, are organized to promote faculty collaboration. International events are also organized, such as the acquisition of the Coursera learning platform, lectures by representatives of the University at Buffalo, etc. There are also regular faculty meetings to share experience.

The academic staff cooperation is established at joint faculty meetings held twice a semester, where the curriculum of the program, course sequence, aims, learning outcomes, and student progress are discussed. Once a year, faculty members meet individually with the head of the program to discuss a specific topic. The academic staff members of the program cooperate in the implementation and improvement of the content of the study courses and participate in strategic meetings within a group or individually.

The program management and administration coordinate the planned examinations within the courses to ensure that they are as varied as possible (presentations, papers, exams), thus enabling students to understand the material covered through the different forms of examination.

Starting the academic year of 2022/2023, 81 BITL students study in the program. A total of 33 faculty members are involved in the program. It should be noted that there are some subjects that BITL students study together with the "Bachelor of Business Administration" program students. In addition, the teaching staff of the program is recruited based on their professional experience, so that there is a specialist in a particular subject in a particular subject. Throughout the course, the student-to-faculty ratio is kept consistently low so that we can provide individual counseling and feedback.

The balance of the teaching load is also monitored to ensure that there is no duplication of course content and that courses are implemented in accordance with the aims of the program. The process is carried out in cooperation with the Student Self-Government and through the evaluation of the courses and the academic staff. A bi-weekly meeting is organized between the program administration and the Student Self-Government on both the teaching process and the student experience within the program.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	01B00_DBT0(43483)_Diploms.zip	01B00_DBT0(43483)_Diploms.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DBT0(43483)_ProvisionalTranslationofJustification250stud_eng.pdf	AIP atz par SP 250.pdf
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	DBT0(43848)_P5Pielikums.pdf	DBT0(43848)_P5Pielikums.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.1.2_DBT0(43483)_Atbilstība_valsts_prasībām.pdf	P06_3.1.2_DBT0(43483)_Atbilstība_valsts_prasībām.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.3_DBT(43483)_Studiju_kursu_kartejums.pdf	P08_3.2.3_DBT(43483)_Studiju_kursu_kartejums.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DBT0(43483)_Studiju_plans.pdf	P09_3.2.1_DBT0(43483)_Studiju_plans.pdf
Descriptions of the study courses/ modules	A10_DBT0(43483)_StudyCoursesdescr_Eng.zip	A_10_DBT0_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Cybersecurity Engineering (45526)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Cybersecurity Engineering*
Education classification code	*45526*
Type of the study programme	*Academic master study programme*
Name of the study programme director	*Andrejs*
Surname of the study programme director	*Romānovs*
E-mail of the study programme director	*andrejs.romanovs@rtu.lv*
Title of the study programme director	*Doktors*
Phone of the study programme director	*67089514*
Goal of the study programme	*The aim of the study programme "Cybersecurity Engineering" is to prepare top level specialists in cybersecurity who can (1) understand and develop the cybersecurity policy of companies and various organizations as well as public space; (2) design, implement, monitor and proactively develop cybersecurity measures; (3) conducting international research in cybersecurity; and (4) continue education for professional development or in doctoral studies.*
Tasks of the study programme	*General tasks of the study programme: - to provide competitive academic higher education in accordance with international standards, to prepare students for practical work, to develop skills of scientific research work and to promote their use; - to ensure the development of the content of the study programme, the study process, scientific research work and changes in accordance with the tendencies in the field of cybersecurity, international practice, science and didactic practice; - to provide students with comprehensive knowledge in cybersecurity engineering, to develop specialist skills and competencies in accordance with the requirements of the labour market; - to promote interest in further education and development, supplementation of academic and professional knowledge; - to stimulate students' interest in the processes taking place in society, to stimulate the development of students into a positive, modern, responsible and capable personality who is able to act independently and make decisions independently; - to promote the interaction of the academic staff and students in the performance of scientific research work and in the practical use of the obtained results in accordance with the international standards and tendencies in the field of cybersecurity; - to promote and develop the international exchange and participation of academic staff and students in research projects.*

Results of the study programme	*As a result of the studies the graduate is able to: - identify, justify and formulate information technology security issues; - design, implement and operate cybersecurity management systems; - analyse, evaluate and develop management systems according to IT security requirements; - develop a corporate digital strategy and align it with the information security strategy; - critically analyse a system monitoring data, identify and manage cybersecurity risks; - apply IT, cybersecurity, data mining and integration tools and techniques, as well as social technologies to protect company information assets; - develop organizational measures and technical solutions for cybersecurity threats; - integrate information security solutions at the network, hardware, software data and process levels and synthesize unified and systemic security management solutions; - ensure safe operation of engineering and socio-technical systems; - provide organizational measures and technical solutions for the protection of the company's critical infrastructure; - assess and ensure that information security solutions meet industry standards and legal requirements; - communicate, advise, collaborate and argue for cybersecurity objectives and outcomes; - independently conduct scientific research in information technologies.*
Final examination upon the completion of the study programme	*At the end of the studies, students must develop a Master thesis in the amount of 20 CP (30 ECTS). The student develops the master's thesis independently during the last semester of the studies, in consultation with the supervisor. If necessary, the student can arrange consultations with external specialists in the relevant field of research. To successfully complete the study programme students must pass the final state examination which is evaluated according to the 10-point system. Part of the final assessment is the oral defence of the master thesis. The quality of the subject matter, scope, management, literature review, and oral defence are determined by the official "Regulations on the development and defence of the master thesis". The list of possible topics for the Master thesis is confirmed in council meeting by the RTU Institute of Information Technology.*

Study programme forms

Full time studies - 2 years - english

Study type and form	*Full time studies*
Duration in full years	*2*
Duration in month	*0*
Language	*english*
Amount (CP)	*80*

Admission requirements (in English)	*Bachelor degree in engineering science or computer sciences, or professional bachelor degree in the areas of practical activity of the mentioned fields of science, or comparable education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Master’s Degree of Engineering Science in Cybersecurity*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

License No 04052-180 for the right to implement the Academic Master Study Programme "Cybersecurity Engineering" was received on 27 April, 2020 with a two-year validity period. The admission of students did not start during academic year 2020/2021 due to the program's focus on foreign student training and the significant mobility restrictions during the Covid-19 pandemic. Student admission started during academic year 2021/2022, and currently 25 students are mastering the study courses of the 2nd semester. It is planned to increase the number of students to 40 in academic year 2022/2023.

The statement of admission requirements has been specified to harmonize it with other programs within the study field: Bachelor's degree in engineering or natural sciences or professional Bachelor's degree in the relevant practical operation fields in the mentioned fields of science, or compatible education.

Other main parameters of the programme - implementation language (English), implementation type (full-time intramural) and the granted degree have not changed in the reporting period.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program "Cybersecurity Engineering" is one of the fundamental programmes of the field of computer science and information technology in accordance with the recommendations of ACM/IEEE "A Report in the Computing Curricula Series" and is being developed in accordance with the strategical aims and tasks of the RTU study field "Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science", which envisages the provision of a high-quality study process, excellent research, sustainable valorization, and smart digitalization.

The name of the academic study programme accurately characterizes the study field, the aim and the learning outcomes of the study program. The student of the program acquires the necessary knowledge, skill and competence to perform comprehensive and effective activities in the field of cybersecurity engineering in the selected business field – development, implementation, improvement and management of cybersecurity management systems, develops awareness of professional ethics and socially responsible management, obtains a wider horizon that provides the basis for further studies to acquire knowledge and skills in the next education cycle.

The code of the study programme is 45526 in the thematic group Engineering and Technology Education in the group of Other Engineering Education programmes. Cybersecurity belongs to the field of engineering and technologies, it has been developed in accordance with the strategical specialization area of Riga Technical University in engineering and technology, and its curriculum is based on information technology solution development for use in companies and organizations.

The volume of the study programme is 80 CP and duration of studies is 2 years, which complies with the Cabinet Regulation No 240 13 of May 2014 “Regulations on the Standard of State Academic Education”. Such duration and volume of the program allows to further improve the knowledge and skills acquired in the undergraduate studies and to allocate enough time for the scientific research work throughout the development of the Master Thesis. The realization of the programme conforms with the requirements of part two of Section 55 of the Law on Higher Education Institutions (see statement of the Council of Higher Education of 7 November 2019 No 1.10/70 - Annex No 29).

The students admitted in the programme shall have a Bachelor’s degree in engineering or natural sciences or professional Bachelor’s degree in the relevant practical operation fields in the mentioned fields of science, or compatible education.

The aim of the study programme is to educate and train high-level specialists in cybersecurity that

- would understand and develop cybersecurity policies for companies and different types of organizations as well as for the public space,
- would develop, implement, manage and proactively improve the measures for cybersecurity provision,
- perform research in cybersecurity on an international level,
- continue education for professional competence advancement or at PhD study programs.

The student of the academic Master Studies acquires the necessary knowledge, skill and competence to perform comprehensive and effective activities in the field of cybersecurity engineering in the selected business field – development, implementation, improvement and management of IT security management systems, develops awareness of professional ethics and socially responsible management, obtains a wider horizon that provides the basis for further studies to acquire knowledge and skills in the next education cycle.

The degree to be acquired in accordance with the study field is *Master's Degree of Engineering Science in Cybersecurity*, see Annex No 28. The degree to be acquired is related to the study program’s fields of scientific specialization Electrical Engineering, Electronics, Information and Communications Technologies in the area of information technologies. To ensure acquisition of a comprehensive education in engineering and cybersecurity, the learning outcomes combine mastering of engineering principles and theoretical background, mastering the theoretical background of computer science, mastering specific aspects of cybersecurity, as well as development and improvement of research skills in the field of cybersecurity.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The current rapid increase of ICT use in the society, economy and state governance has caused a dramatic increase of information security risks, which threaten the economic development of the state and public safety. In 2021, the number of cybercrimes increased by more than 600% (https://purplesec.us/resources/cyber-security-statistics/). In 2022, the global cybersecurity market will become even more hostile and unstable, and companies will find it difficult to follow the continuous altering cybersecurity and digital transformation requirements. The primary factor that adversely affects cybersecurity is the lack of qualified human resources. According to the opinions of industry experts, in the global market, the deficit of cybersecurity specialists amounted to 2.7 million in 2021 (https://blog.isc2.org/isc2_blog/2021/12/find-a-new-cybersecurity-job-in-2022.html), besides, the number of cybersecurity vacancies is going to grow with 3.5 million new vacancies expected to open until 2025 (https://cybersecurityventures.com/jobs/).

In accordance with the laws and regulations of developed countries, companies should appoint a knowledgeable specialist responsible for IT security. The task of the cybersecurity specialist in organizations and companies is to manage security solutions, advise users and provide expertise related to IT safety matters. Implementation of these tasks requires a wide spectrum of knowledge, including the management of computer networks, software, integrated systems, critical infrastructure security, which is provided by the study program, combining the competitive advantages offered by several organizational units of RTU (RTU FCSIT Institute of Information Technology, FCSIT DADI Department of Computer Network and Systems Technology, FCSIT LDI Department of Applied Computer Science, FEEE IEEI Department of Industrial Electronics and Electrical Technology, FET Department of Transport Electronics and Telematics, and FEEM RKI Department of Quality Technology) in order to create a unique, innovative and interdisciplinary study programme that is realized in English and available for a wide range of students. Technological and academic support for implementation of the program is provided by companies Palo Alto Networks (https://www.paloaltonetworks.com) and Check Point Software Technologies (https://www.checkpoint.com/), in accordance with the contractual relations with RTU, providing the opportunity to use virtual infrastructure, cyber polygons, computer networks, as well as access to study materials, guest lectures and certification training for students and lecturers on relevant cybersecurity technologies and approaches.

It is noted in the order by the Cabinet of Ministers No 93 (16 February, 2021) “On the National Industrial Policy Guidelines for 2021-2027” that the field of ICT plays an important role in the Latvian economy with a rapidly growing added value, including cybersecurity in the list of topical niche themes of ICT. The contribution of ICT amounts to approximately 5% of the total GDP and has grown significantly throughout the last decade. People working in ICT earn 60% more than the national average, and it is the second best paid field (https://stat.gov.lv/lv/statistikas-temas/darbs/alga/preses-relizes/8227-darba-samaksas-parmainas-2021-gada). Summarizing the aforementioned, it can be concluded that there is a potential for great long-term employment opportunities for the graduates of the program, as cybersecurity specialists are vitally important for the national development.

Student admission started during academic year 2021/2022, at the moment of writing this report, no student has graduated from the program.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Student admission started during academic year 2021/2022, and currently 25 students are mastering the study courses of the 2nd semester, from which 20 are foreign students and 5 are local students studying on the state budget funds.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The aims, tasks, curriculum developed for the study programme “Cybersecurity Engineering” and methods for its implementation are appropriate for the current industry, technology and sustainability management development trends. All study courses included in the study program are related to the aims, tasks, and learning outcomes of the study programme (the content mapping of the study program is provided in Annex 8). Study course descriptions are available in Annex 10.

The aim of the Master study programme “Cybersecurity Engineering” is to educate and train high-level specialists in cybersecurity, who 1) would fully understand and develop cybersecurity policies for companies and different types of organizations, and public space; 2) would create, implement, manage and proactively improve the measures for ensuring cybersecurity; 3) would carry out research in cybersecurity on an international level; and 4) would continue education for professional competence advancement or at PhD study programs.

The volume of the Master study programme is 80 CP, which consists of compulsory study courses in Part A amounting to 40 CP, compulsory elective study courses in Part B making up 16 CP, free elective study courses in Part C amounting to 4 CP and the state examination, namely, the Master Thesis in the volume of 20 CP.

The compulsory courses of the programme provide advanced theoretical knowledge in cybersecurity covering such aspects as research and provision of security of computer networks, software, information systems, industrial and critical infrastructure. These courses also ensure development of research skills necessary for acquiring an academic Master's degree.

Specialization study courses (Part B, Sub-part B1) develop the knowledge framework in cybersecurity in such areas as engineering systems, socio-technical systems, e-commerce, data mining, and data integration.

Study courses in Sub-part B2 complement the technical curriculum of the programme with the knowledge on human and business behavior in the digital era.

Part E of the study programme "State Examination" focuses on testing student ability for independent self-development and self-education in the field of cybersecurity, as well as their ability to perform scientific research.

In order to meet the legal requirements, and if a foreign student has not completed the national language study course in the lower level study program, then the study course VSL711 Latvian language for foreign students 1 CP should be completed in addition to the study programme volume. If a student has not had study courses on civil defence or environment protection then these study courses (VAS038 Environment and Climate Roadmap 1 CP and ICA301 Civil Defence 1 CP) students should be completed within part A, reducing the volume of part C accordingly.

Table 1

List of the Courses

No	Code	Title	Credit points
A		**Compulsory Study Courses**	**40.0**
1	DMI745	Introduction to Cybersecurity	4.0
2	DOP715	Reliability of Information Systems	4.0
3	DOP700	Enterprise Information Technology Architecture, Applications and Integration	4.0
4	DMI746	Cybersecurity Solutions in High Performance Computing Environment	4.0
5	EEI706	Control Fundamentals of Critical Infrastructures	4.0
6	EEI707	Industrial Safety	4.0
7	DST715	Network Security	8.0
8	DPI736	Software Security	4.0
9	TRL342	Cryptography and Data Security Technologies	4.0
B		**Compulsory Elective Study Courses**	**16.0**
B1		**Field-Specific Study Courses**	**12.0**
1	EEI705	Design of Adaptive Systems	4.0
2	DST717	Engineering Systems Security	4.0
3	DMI747	Sociotechnical Systems Modelling	4.0

4	DMI728	Data Mining and Knowledge Discovery	4.0
5	DOP711	Project Management	2.0
6	DMI748	Secure E-Commerce Technologies	2.0
7	DOP724	Data integration technologies	2.0
B2		**Humanities and Social Sciences Study Courses**	**4.0**
1	IVZ783	Social Responsibility and Business Ethics	4.0
C		**Free Elective Study Courses**	**4.0**
E		**Final Examination**	**20.0**
1	DMI002	Master Thesis	20.0

The goals and results of the study program are achieved through the realization of study course goals, see Annex 8 "Mapping of study courses" in the appendix, which collects data on the balanced contribution of study courses to the achievement of the results of the study programme.

The updating of the study course content is planned based on industry requirements, labour market and scientific trends. Namely, regularly renewing literature and information sources, inviting guest lecturers from the industry, reviewing and improving course content after consultations with industry experts, incl. in consultation with collaboration partners from academia and industry, e.g. Palo Alto Networks and Check Point Software Technologies (see Annexes “Check Point Agreement” and “Palo Alto Agreement”). The course content could be updated based on the conducted research, e.g. Erasmus+ project "Cybersecurity Curricula Recommendations for Smart Grids" (2021-2023).

Content of the study curses is updated in accordance in with RTU regulations. If significant changes are made to the course content, they are reviewed by the "Information technologies, computer engineering, electronics, telecommunications, computer management and computer science" study field commission, which also includes industry representatives. Operational changes are made by preparing the calendar plan for the current semester in accordance with the RTU regulations "On the use of the RTU e-study system in study subjects". The methodological commission of the FCSIT works to examine current issues. In the faculty seminar for teaching staff, questions about the digitization of the study process, the use of modern study methods, evaluation of study results and academic honesty are considered.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

One of the aims of the study program “Cybersecurity Engineering” is development of scientific research skills of the students. It is achieved by including information on the newest scientific achievements in the study course curricula, motivating students to implement research within the study courses, involving students in scientific research projects, students also carry out research during the development of their graduation papers. Scientific research is mostly carried out in such fields as electrical engineering, electronics, systems analysis, modelling and design in the field of information and communication technology, and cybersecurity.

The most important fields, where students are involved in research:

1. Theoretical and applied aspects of cybersecurity;
2. Information system and data security;
3. Cybersecurity of critical infrastructure;
4. Modelling of cybersecure socio-technical systems.

The latest findings in these fields are integrated in the study courses. Currently, an international project is being realized in the ITI Institute on the integration of cybersecurity aspects into study programs on smart electric grids: ERASMUS + project “Curricula Recommendations for Smart Grids” (2020–2023). The plan is to actively involve students in research in the framework of the study program, namely, to make them participate in projects and co-author scientific publications.

In order to create a dynamic scientific environment, the Institute of Information Technology publishes a collection of articles “Information Technology and Management Science”, organizes the annual international scientific conference “IEEE Information Technology and Management Science Conference” (http://itms.rtu.lv/), the seminar of the institute and a section in the students’ conference. It is planned to involve students in all these events.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study programmeme “Cybersecurity Engineering” is carried out in English and is implemented in the form of full-time intramural studies. Implementing the programme curriculum, all provisions of the regulatory enactments are considered, basic principles of organizing the study process determined by RTU and all study course requirements are met. Study course descriptions present information on the relevant knowledge, skills and competences and their assessment system, define the expected learning outcomes for which credit points are granted. Assessment of the student knowledge, skills and competences is regulated by the decision of RTU Senate of 27 May, 2017, “On Regulation on the Assessment of Learning Outcomes”, which comply with the basic principles and processes of education assessment within the relevant study cycle defined by the by-laws issued by the Cabinet of Ministers. The summative assessment system, where the final grade consists of several components, is used to assess student achievements. Full-time studies correspond to the volume of 40 CP during an academic year, and 1 CP translates into 40 academic hour load during a single week of studies. At the Master level, 40% of the study load is made up by contact hours and 60% - by independent work.

The pedagogical methods for delivery of the study courses are selected by the responsible instructors considering the specifics of the study programme and student needs. Lectures are often carried out in a study room, however the practical classes - in small groups, in the computer room. In academic matters, individual approach is provided according to the methodology approved by the order of RTU Rector “On Work Planning Guidelines for the Academic Staff”, where it is specified that the academic staff shall ensure tutorials per every 25 students in the lecture flow amounting to 15% from the total lecture hours. Additional separate tutorial hours are designated for managing term papers and projects, as well as graduation papers. Pre-examination tutorials are organized before examinations. If necessary, students may contact the academic staff directly outside tutorials by sending the relevant questions as messages or in the study course forum in the ORTUS system or ask these questions via e-mail.

The basic principles for ensuring the internal quality of the study programme are:

- Instructor responsible for the study course is responsible for achieving specific study aims and completing the tasks of the study course,
- The responsible organizational unit controls the activity of the academic staff involved in the study process,
- The planning and management of the study program is carried out by the head of the study programme,
- Methodological activities are realized via methodological seminars at the organizational unit,
- Overall, the learning outcomes are evaluated and changes in the study programme are initiated by the council of FCSIT Institute of Information Technologies,
- Students also evaluate the realization of study courses by filling out surveys at the end of each semester; survey results are evaluated by the appropriate academic staff and the head of the study programme and make decisions on introducing changes in the study course delivery process, if necessary.

The didactical concept of the study programme is realized through the application of progressive study methods. It envisages implementation of the study process that ensures successive and in-depth acquisition of the knowledge provided within the study programme. Thus, in the 1st year, students master the compulsory study courses from Part A and elective courses from Part B1. In the 2nd year, they continue to master the compulsory study courses from Part A and improve their knowledge within compulsory elective courses from Part B, and also freely selected elective courses (Part C) and select the topic of their Master Thesis, the development of which is allocated for the spring semester of the 2nd year. In addition to the study courses included in the programme, foreign students master the study course VSL711 the Latvian Language amounting to 1 CP within Part C.

The framework of each study course describes its assessment system that represents all types of tests that must be completed by the student. When developing the assessment criteria within the study programme, the following basic principles have been considered:

- the principle of summarizing positive achievement;
- the principle of compulsory assessment;
- the principle of dependency and compatibility of assessment criteria;
- the principle of assessment form diversity;
- the principle of accessibility of testing.

Student subject knowledge is assessed following Cabinet Regulations No 2 of 3 January 2002 “Regulations on the Standard of State Academic Education” and the respective decision of the RTU Senate (RTU Regulation on the Assessment of Learning Outcomes of 29 May, 2010, Minutes No 539).

It is allowed to publicly present the Master Theses if students’ knowledge and skills have been positively assessed in all study courses of the programme. In RTU, defence of the Master Theses is organized in accordance with the procedure adopted by RTU, providing for the opportunity for representatives from partner universities to take part in the work of examination committee (on-site or remotely).

Assessment criteria of the education to be obtained are based on the learning outcomes of the study programme and the study courses. They are used in assessment of the quality of student's practical works, lab works, study works, independent work, as well as other activities, examinations and the Master Thesis. Specific assessment criteria within each course are defined by the responsible instructor. Students are informed about the assessment criteria at the beginning of the semester; they are accessible electronically in ORTUS e-learning environment.

RTU e-learning platform ORTUS (www.ortus.lv) is used in the implementation of the study programme. ORTUS provides access to all relevant information in the study process - study course materials, information on student's performance, topical announcements, access to the e-resources of the RTU Scientific Library, e-mail, etc. The faculty can set up different exercises and tests for evaluation and self-evaluation of knowledge in the e-learning environment.

The most important aspects of the student-centered approach are described below.

1. Involvement of students in the study process and updating of the curriculum

According to RTU procedures, students can regularly give feedback about the curriculum. Students at the program are regularly involved in assessment of the study programme quality and take part in decision-making bodies and advisory bodies (the Faculty Council, the Methodological Committee, the Study Field Committee). In addition to formal processes, students regularly meet with the Programme Director, when the content and quality of studies is discussed. Mid-term and semestral surveys are organized to let students give feedback about the study courses. Furthermore, at any time students can apply to the Programme Director or RTU Study Department with an option to complain anonymously, in order to let them know about problems arising during the studies. Graduates of the study programme fill in the form about the studies in general.

2. Learning outcomes

At the study courses, the academic staff clearly define the learning outcomes to be acquired, as well as connect the results with the study programme outcomes and credit points of the course. The academic staff take into account diversity of students, offering tasks of different complexity, as well as offering learning materials for the acquisition of both the basics of a study course and the in-depth knowledge of the curriculum of a study course. Students also are offered a vast variety of educational materials (documents, presentations, video recordings, interactive educational materials, etc.).

3. Mobility

RTU offers a wide variety of opportunities to participate in international mobility: 1) Erasmus+ programme; 2) Nordtek and Baltech programs; 3) specialized cooperation programmes and 4) financing of projects. In the framework of exchange programmes, RTU provides students with an opportunity to study voluntarily at some foreign university for some period of their studies (normally, one academic term, but other mobility duration options also are possible), gaining a foreign IT education experience. Furthermore, RTU regularly takes up opportunities of attracting visiting researchers, who share their experience with students through individual guest lectures or the whole study course. Also, when meeting visiting professors at specially organized workshops, the academic staff involved in the programme can adopt good practices, which visiting professors share. Mobility opportunities also are the means for advancement of academic staff qualification, wherein they gain experience at foreign universities. More detailed information about the attracted guest professors and mobility of the academic staff is given in Part 3.4.1. “Compliance of the qualification of the involved academic staff”.

4. Social dimension

RTU has established student support services, provided by RTU Student Service, including psychologist counselling. FCSIT has a student self-government that directly helps students get involved in the study process and provides support to them. Students are awarded with scholarships on a competitive basis, and a specific support is planned for students with special needs. Students take up employment early. Online attendance opportunities help students reconcile studies and work.

5. Teaching and learning methods

Within the program, various teaching and learning methods mentioned above are implemented, they are adapted by the academic staff to each particular situation (see the description at the beginning of the section). Students can attend individual consultations, including communication in the e-environment using RTU licenses on Zoom and MS Teams platforms, as well as Moodle instant message services.

6. Learning environment

In 2021, a new FCSIT faculty building was opened at 10 Zunda Krastmala. Students have access to all technical equipment necessary for modern IT education - computer classes, including virtualized computer classes. The new building is equipped with quiet working and recreation zones on each floor. Also, modern video conference tools like Zoom and MS teams licenses for distant learning and consultations, and other software licenses including academic ones are available (for example, MS Office, as well as different software development environments and tools).

In the process of programme implementation, the librarians cooperate with the academic staff in order to improve the teaching and learning processes. During the first year of studies, students are familiarized with the resources and databases available at the library. According to the existing demand, RTU Scientific Library is being digitized, offering yet more and more resources in the electronic format, providing students with the access to the most significant databases of research articles in IT (IEEE, SpringerLink, ACM, ScienceDirect, Wiley etc.).

7. Development of the academic staff competences

The academic staff involved in the implementation of the programme is provided with opportunities to improve their methodological and didactic skills on a regular basis. The process of academic staff competence development includes methodological seminars organized by the Institute of Information Technology and FCSIT on the application of teaching and learning methods, including innovative learning methods, as well as methodological conference organized by RTU and LSCM consortium.

8. Extracurricular student activities offered by the Institute of Information Technology, RTU International Cooperation and Foreign Students Department and student self-government - students are involved in scientific activity and research on the issues topical for the industry. The Student Scientific and Technical Conference is organized on an annual basis, where students can get their first experience of publication of their research results. Students at the programme are offered a vast variety of extracurricular activities (sport teams, dance groups, choirs, etc.).

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

Student admission commenced in academic year 2021/2022, at the moment of drafting this report, no graduation papers have been developed at the programme. It is planned to offer the themes of graduation paper in close cooperation with the programme partners – leading world companies in the field of cybersecurity (Palo Alto Networks https://www.paloaltonetworks.com/ and Check Point Software Technologies https://www.checkpoint.com/) and representatives of the Latvian employers.

In accordance with the competence of teaching staff and current trends in the industry and the labor market, the following topics of final theses could be proposed:

- Methods and strategies of cybersecurity
- Applying cybersecurity models
- Modeling Security Risks
- Developing Information System Security
- Analysis and Mitigation of Cyber Attacks
- Evaluation and Treating cyber events
- Computer network monitoring and control
- Improving software security
- Managing identity and access
- Protection of web security
- Secure workspace from malwares
- Simulate a cybersecurity incident
- HPC Cybersecurity Solutions
- Critical infrastructures cybersecurity management

.

The development and defense of final theses will take place in accordance with the Regulation on final examinations at Riga Technical University (https://international.rtu.lv/wp-content/uploads/sites/65/2021/02/08.-Regulation_on_Final_Examinations_at_RTU.pdf). According to this regulation, the development of the final thesis takes place in accordance with the schedule of thesis development, which the student agreed with the supervisor. The actual performance of each student's final thesis is controlled by the supervisor and at least twice by a representative of the academic staff or a commission appointed by the responsible structural unit. The structural unit organizes the pre-defense of final theses, the purpose of which is to evaluate the progress of the thesis development and provide the student with recommendations for improving the thesis. If the committee assesses the results achieved during the development of the final thesis in the pre-defense as insufficient, the director of the study program may not allow the student to take the final exam within the term provided for in the study plan. The readiness of the work for submission is confirmed by the supervisor. Next, the work is submitted to the reviewer for consideration. Before defending the final thesis, the supervisor's review and the review prepared by the reviewer are attached to the final thesis. The decision on the admission of the final thesis for defense, considering the results of the plagiarism control, the review of the supervisor and the review of the reviewer, is taken by the director of the study program or a representative of the academic staff recommended by him, approved by order of the dean. The final exams are held at an open meeting of the Commission. The student's performance in the final exam is evaluated by the Commission in a closed session, based on the quality of the student's reports and answers to questions related to the thesis developed, to the most important basic, theoretical and special science study courses, as well as considering the supervisor's feedback and the reviewer's assessment. The Commission evaluates the final exam with one mark on a 10-point scale. The lowest passing score is 4 (almost average).

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- FCSIT Institute of Information Technology;
- FCSIT DADI Department of Computer Network and Systems Technology;
- FCSIT LDI Department of Applied Computer Science;
- FEEE IEEI Department of Industrial Electronics and Electrical Technology;
- FET Department of Transport Electronics and Telematics;
- FEEM RKI Department of Quality Technology

RTU institutes and their departments ensure the training and methodological work: develop and update the curriculum, provide delivery of corresponding study courses, supervision and examination of Master Theses and carry out other activities related to teaching, methodological and research work. Elective study courses are offered also by other organizational units of RTU and other higher educational establishments. The study programme is granted with assistance of the general RTU support staff, which provides the functioning of the infrastructure.

Riga Technical University provides the study program with a corresponding learning environment. It comprises:

- lecture halls and classrooms,
- laboratory equipment,
- e-learning environment,
- bibliographic and other resources.

For each study course, the study base and resources necessary for it are indicated, which ensure the achievement of the results of the study program through the realization of the goals of the study courses.

The studies take place mainly at RTU Ķīpsala Campus. The majority of the study courses is delivered in the lecture rooms of the Faculty of Computer Science and Information Technology at 10 Zunda krastmala, which was opened in 2021. The classrooms provide a modern learning environment with spacious lecture rooms, free access to computer rooms and classrooms for individual studies and extracurricular activities. The conference center has a large auditorium with 500 seats, the faculty has 12 auditoriums with 25-200 seats and 10 computer classrooms with 20-25 workplaces. Students can use their laptops and connect to RTU Wi-Fi networks. The lecture halls are equipped with modern audio and video equipment, including a digital projector, a computer, a remote control, audio devices, microphones and cameras. The faculty is located in the same campus as RTU Scientific Library, which provides rooms for group work and quiet reading rooms. Software appropriate for the needs of study program and relevant trends is used in the study process.

Information system and computer network security study courses use *reconnaissance tools* like Google hacking, ns lookp, netcraft, as well as the tools that help in performing tests for the devices in a network, information systems and web software ((Metasploit framework, armitage, nmap, netcat, tcpdump, Burp suite, Wireshark, Airodump-ng, nfcapd, nfdump, Snort).

The following resources are used for security testing and provision of computer networks:

- Simulation environment - GNS3 where network topology and laboratory works are created;
- Kali Linux distributive - used to carry out attack laboratory works.
- Security Onion and/or SELKS Linux distributive - used to carry out defence laboratory works.
- Mikrotik CHR virtual instances - used to carry out defence laboratory works.
- Checkpoint and/or PaloAlto laboratory works - used to demonstrate the opportunities of the best (according to Gartner analysis) industry offers.

Practical classes on cybersecurity of critical infrastructure are held at the RTU IEEI building, which has a modern building management system with sensors, climate control systems, energy efficient lighting, etc. that are used as visual aids and research objects. Practical classes are organized in several RTU laboratories: Training Laboratory of Power Electronics, Research and Training Laboratory of Production Process Automatization, Research and Training Laboratory of Computer Control, Research and Training Laboratory of Microelectronics and Sensors, Research and Training Laboratory of Energy Efficiency, Training Laboratory of Electronic Devices, Training Laboratory of Electrical Engineering, Laboratory of Industrial DC Power Supply Systems (AREUS Demo Lab).

For additional convenience of RTU students, academic staff and employees, RTU leases “Microsoft Windows” and “Microsoft Office” software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail service.

All the aforementioned equipment and laboratories are successfully used in the study process and student research. The infrastructure and resource base for implementing the study program, due to the high level of digitization, provides the opportunity to increase competitiveness, operation quality and efficiency of the university, as well as ensure availability of information by integrating IT solutions in the administrative, study and scientific work processes of the university, providing the students, administrative and academic staff with modern, reliable, safe and unified IT infrastructure and high-quality IT services.

In order to provide simple and effective identification of IT users, the IT user identity management system has been introduced, as a result, each IT user has a unique electronic identity created and maintained, which is valid in all information systems. In addition to the mentioned above, a user session management system in IT systems is provided, where at one single application in RTU information systems, IT users do not need a repeated authorization. This offers the user experience of a joint integrated information system, which remembers various identification data and inputs it again implementing different scenarios of IT application.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalogue of all IT services in the same place.

The overall detailed description of the infrastructure and material-technical base of the study course, as well as the methodological and informational provision, is given in the description of the course, part II, chapter 3 "Resources and provision of the study course", where subsection 2.3.2 is devoted to the description of the infrastructure and material-technical provision, while 2.3. 3 provides a detailed description of the methodological and information provision (including the range of options offered by the RTU Scientific Library (SC)).

RTU Scientific Library (SC) is a library of national importance, which provides RTU study process and research activities with the necessary information, provides librarian, bibliographic and informational services for RTU students, teaching staff, and employees. SL has 1.3 million printed documents and e-resources in databases corresponding to RTU branches. Stock replenishment takes place according to the recommendations of study program managers and researchers, considering the allocated RTU funding.

SL information sources are located in the open access collection. Books and periodicals according to RTU study directions are located in ZB Central Building at P. Valdena street 5 according to UDC indexes. They are always available to users. Publications not available at SL are delivered via Interlibrary Loan or International Loan. Internet access is provided throughout SL.

RTU subscribes to internationally recognized electronic databases with the help of EIFL (Electronic information for Libraries, http://www.eifl.net/). Teaching staff is adviced to recommend to students one of the e-books available in the bibliographic resources at SL. To deepen knowledge in the subject of the study courses and to conduct appropriate research, Cybersecurity engineering study program students widely use electronic resources, such as ScienceDirect, SCOPUS, Web of Science, IEEEXplore, ProQuest Ebook Central, EBSCOhost, Wiley Online Library, SpringerLink, as well as Latvian databases (LETA, Letonika, Latvian standards database).

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

Student admission commenced in academic year 2021/2022 and currently 25 students are mastering the study courses of the 2nd semester, from which 20 are foreign students and 5 (RTU Order No. 02000-1.1-e / 88 from 26.07.2021) are local students studying on the state budget funds.

Total revenues of the study program for the study year 2021/22 is 88934.01 EUR, of which the tuition fee is 56867.24 EUR from foreign students and 32066.77 EUR from local students.

Study program costs per student for the study year 2021/22, as well as the distribution between cost items, are summarized in the table:

	International students		**Local students**	
Cost Item	***Total EUR***	***%***	***Total EUR***	***%***
Average actual costs per 1 student, EUR	2707,96	100%	4008,35	100%
Remuneration	1149,88	42%	1584,98	40%
Employer's SSIC, compensations and benefits	294,20	11%	377,61	9%
Business trip expenses	2,62	0%	0,00	0%
Payments for services	846,62	31%	98,09	3%

Materials, energy resources, inventory	24,33	1%	5,28	0%
Purchase of books and magazines	72,10	3%	177,41	4%
Purchase and modernization of equipment	11,35	0%	52,78	1%
Administration costs	234,31	9%	603,99	15%
Infrastructure costs	54,54	2%	860,88	22%
Social security costs	18,02	1%	247,32	6%

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "*Funding distribution between the cost items*".

Information on the minimum number of students required for the study programme is given in the Annex to the Self-Assessment Report “*Minimum number of students to ensure the cost-effectiveness of the study program*”.

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

The qualifications of the academic staff involved in the implementation of the study programme comply with the guidelines for the implementation of the study programme and the requirements of the regulatory enactments, which ensures achievement of the aims and learning outcomes of the study program and the corresponding study courses (view Annex 19 and Annex 20). In total, 27 members of academic staff are involved in the implementation of the study programme, 20 hold a PhD. The composition of academic staff by positions is presented in Fig. 1.

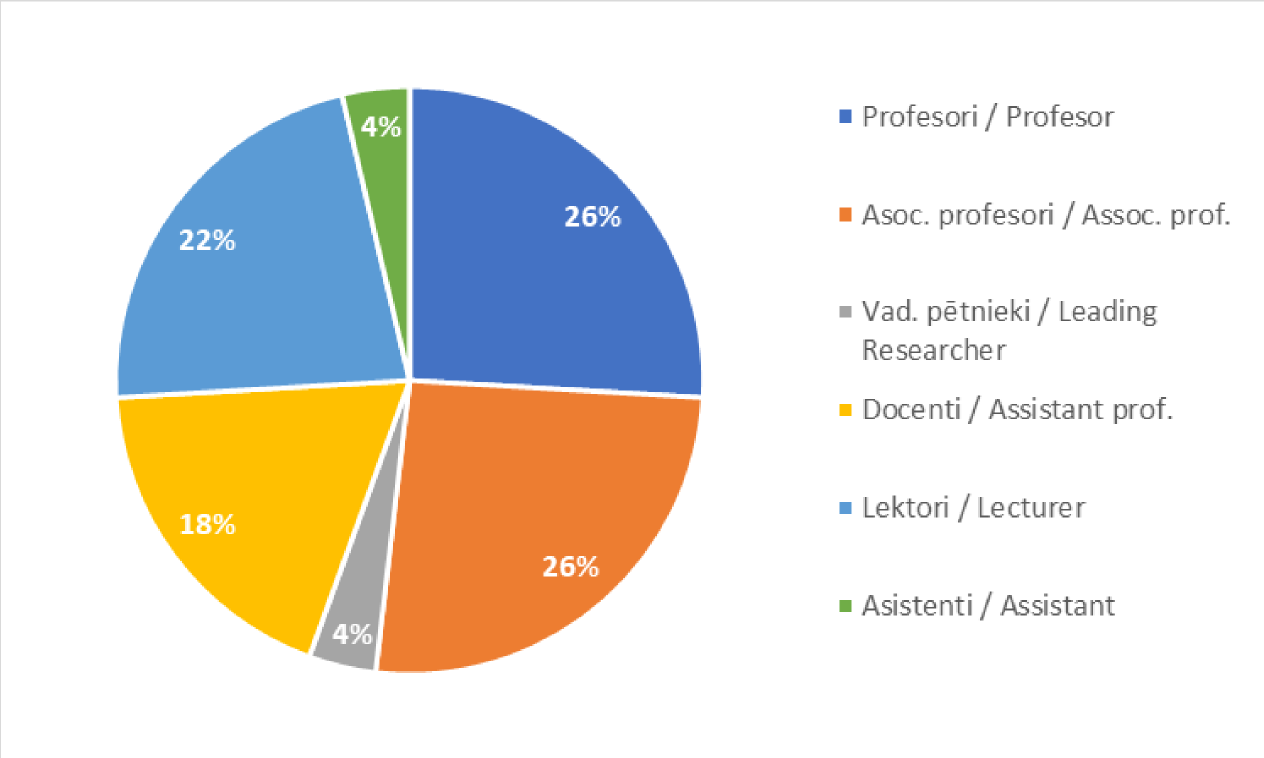


Fig. 1. Composition of academic staff by positions.

The following staff are responsible for implementation of the study courses:

- **RTU Faculty of Computer Science and Information Technology** professors J. Grabis and E. Ginters, associate professors A, Romānovs, A. Lektauers, J. Kampars, S. Paršutins, E. Nazaruka and D. Bļizņuks, assistant professor (practical) J. Šlihte;
- **RTU Faculty of Electrical and Environmental Engineering** professor N.Kuņicina;
- **RTU Faculty of Electronics and Telecommunications** professor E. Pētersons;
- **RTU Faculty of Engineering Economics and Management** professor I. Lapiņa.

All instructors responsible for the study courses hold a PhD in the corresponding field.

Information on the leading members of academic staff involved in the implementation of the study program is provided below.

Assoc. prof. Andrejs Romānovs – Dr.sc.ing., associate professor and leading researcher at RTU Institute of Information Technology, Head of the Department of Modelling and Simulation, Head of RTU Master study programmes "Logistics and Supply Chain Management" and "Cybersecurity Engineering". 20 years of pedagogical experience in delivery of numerous study courses at Riga Technical University and more than 30 years of professional experience in IT. Co-author for more than 100 international scientific publications in the fields of information technology modelling, cybersecurity, logistics and supply chain management, 58 of which are indexed in Scopus data base (Scopus h-index is 9). Organized more than 30 international scientific conferences and took part in implementation of several scientific research projects in Latvia and internationally. A member of councils and associations in several fields: LCS expert in the field of Information Technology, member of RTU FCSIT Council, member of RTU ITI Council, member of the Latvian Society for Modelling and Simulation, senior member of the Institute of Electrical and Electronics Engineers (IEEE), member of Information Systems Audit and Control Association (ISACA); member of academic networks – IBM Academic Initiative, SimFlex for Academics, Palo Alto Networks, Pearson Higher Education Network, Check Point Secure Academy.

Prof. Jānis Grabis – Head of the Institute of Information Technology of RTU Faculty of Computer

Science and Information Technology. A co-author of over 125 “Scopus” indexed international scientific publications about the issues related to enterprise integration, optimization and digitalization of project management and business processes (“Scopus” h-index is 12). Prof. Grabis worked as a researcher or a visiting professor at the University of Michigan-Dearborn and Stockholm University; has led and participated in more than 12 scientific research projects, including EC framework programs, ERDF practice-oriented research, LCS (Latvian Council of Science) Fundamental and Applied Research Program, projects of EEA and Norway grant and State Research Program, as well as in more than 10 contracted works in cooperation with the companies. Head of the Bachelor, Master and PhD study programs in Information Technology. In 2021 was recognized as RTU Academic Staff of the Year.

Assoc. prof. Arnis Lektauers, Dr.sc.ing. – Associate Professor and Leading Researcher at the Department of Modeling and Simulation of RTU FSCIT Institute of Information Technology. A co-author of more than 45 international scientific publications on high-performance interactive computer simulation solutions for complex systems. Participated in more than 10 scientific research projects, including EC Framework Program, EEA and Norwegian grants, State Research Program projects, as well as implemented more than 5 contracted works in cooperation with the enterprises. Along with academic and scientific experience, he has 26 years of professional experience in local and international IT companies. He has been a member of the Modeling and Simulation Group of the NATO Science and Technology Organization since 2011.

Assoc. prof. Jānis Kampars – Member of the Board of the Latvian Open Technology Association, Latvian representative in the group of independent experts of the EC *Destination Earth* initiative. A co-author of more than 30 international scientific publications on cloud computing, horizontally scalable real-time data processing systems, digital transformation indexed in Scopus database (Scopus h-index is 6). Actively cooperates with the Latvian Association of Local and Regional Governments, Riga Planning Region, Riga and Kuldiga Municipalities, the Ministry of Environmental Protection and Regional Development, Latvian State Roads, Latvian Road Maintenance Authority and Latvian companies in the issues of digital transformation, open source and open data promotion, use of digital twins. Assoc. prof. Kampars uses the established cooperation network to enhance the study process. Participated in the implementation of more than 9 research projects.

Prof. Egils Ginters, Dr.sc.ing. (1996), professor and leading researcher (2016) of the Faculty of Computer Science and Information Technology of Riga Technical University, corresponding member of the Latvian Academy of Sciences (2017), full member of the European Academy for Industrial Management (2019), member of the board for several IT companies (1991). Senior member of the Institute of Electrical and Electronics Engineers (IEEE), as well as the Vice- President of the Latvian Society for Modelling and Simulation and a member of the European Society for Social Simulation. Fields of scientific research: Modelling of socio-technical and distributed systems and simulation modelling, use of virtual and augmented reality technologies in restoring human resources communication and working abilities, use of digital technologies in logistics information systems. Simultaneous research result validation in private companies is a characteristic feature of research conducted by Prof. Ginters. Significant international scientific research projects: FLAG-ERA FP7/H2020 FuturICT 2.0 (2017-2021), FP7-ICT-2011-7 FUPOL No. 287119 (2011-2015), FP7-ICT-2009-5 CHOREOS No. 257178 (2010-2014), FP6-IST-2002-2.3.2.6 e-LOGMAR-M No.511285 (2004-2006), LdV SocSimNet LV/B/F/PP-172.000 (2004-2006), LdV LOGIS MOBILE LV/B/F/PP-172.001 (2004-2006), FP5-IST BALTPORTS-IT (2000-2003), LdV LOGIS LV-PP-138.003 (2000-2002), EC INCO Copernicus DAMAC-HP PL976012 (1998-2000), EC INCO Copernicus AMCAI 0312 (1994-1997). Published works: Hirsch index – 12; ORCID ID: 0000-0003-2394-6109, scientific articles that have been indexed in SCOPUS ID: 6506734286 - 81, more than 190 scientific publications, 2 patents. Editor of the journal Mathematics (ISSN 2227-7390, MDPI, Q1 cohort) (2021). Reviewer for the journals: Resources, Conservation & Recycling (2020), Energy for Sustainable Development (2020), Journal of Advanced Research (2020), Cities (2018), Technologies (ISSN 2227-7080) (2018), Heliyon (2017, 2018), Symmetry (ISSN 2073-8994) (2017), Journal of Renewable and Sustainable Energy (2017, 2020), Journal of Mathematics, Science and Technology Education (ISSN 1305-8223) (2016, 2017), Information Sciences (ISSN 0020-0255) (2015, 2016, 2018), Computer & Education (2015, 2016), Computational and Mathematical Organization Theory (ISSN 1572-9346) (2015), Mathematical Problems in Engineering (ISSN 1563-5147) (2015) and others. EC H2020 Framework program expert (2020-2021). Pedagogical work: supervised more than 40 Master Theses and 2 PhD Theses that resulted in obtaining a doctorate.

Prof. Kuņicina - holds a Doctoral degree in electrical engineering and has been elected Professor of Electrical Engineering, Electronics, Information and Communication Technologies (Electrical Engineering and Automation). She holds the Expert status of the Latvian Council of Science in Social Sciences - Educational Sciences until 6 January 2024 and in Engineering and Technology - Electrical Engineering, Electronics, Information and Communication Technology until 3 September 2023. Professor Nadežda Kuņicina conducts research in the field of electrical engineering, mainly related to improving the efficiency of electricity use in industrial electronics and electric vehicles. Nadežda Kuņicina has participated in the development of study programmes, such as Erasmus plus KA 2 Applied Curricula in Space Exploration and Intelligent Robotics Systems - APPLE (2017-20); Electrical Energy Markets and Engineering Education - ELEMEND (2017-21); Innovative Approach towards a Master Program on Smart Cities Technologies - SMARTCITY (2018-21); Development of Practically-Oriented Student-Centred Education in the Field of Modelling of Cyber-Physical Systems - CybPhys (2019-22), Knowledge Triangle for a Low Carbon Economy - KALCEA (2020-23). Within the projects, academic objects and methodological tools have been developed on the following topics: innovation in information and communication technologies; introduction to the specialisation in design of energy-efficient technologies; metrology and mathematical modelling; Internet of Things and smart electrical technologies; energy saving in electrical equipment; electrical processes and equipment in biotechnology; thermal energy, fundamentals of control theory; energy efficient technologies; fundamentals of industrial computer networks; automation theory; automation elements; non-traditional non-contact electromechanical converters; non-traditional energy converter systems and storage; methods of analysis and calculation of electronic circuits. Nadežda Kuņicina develops study materials within the following study courses: “Fundamentals of Industrial Computer Networks”, “Computerization of Mathematical Tasks in Electrical Engineering”, “Elements of Automation”, “Industrial Safety”, “Control Fundamentals of Critical Infrastructures”, “Design of Adaptive Systems”, “Linear and Non-linear Systems” h-9.

Assoc. prof. Ērika Nazaruka. Her scientific publications are related to the formalisation of the software development process, which allows quality control measures to be taken at the system analysis stage. She has completed the course in automation of software functional testing implemented by Accenture Latvian branch. Close cooperation with A1QA (representative in Latvia of “Planet of Testing” Ltd) and Accenture Latvian branch representatives is maintained in the implementation of the study courses.

The database of experts of the Latvian Council of Science (LCS) includes nine academic staff members that are active in the fields of engineering and technology - Electrical Engineering, Electronics, Information and Communication Technology; Natural Sciences - Computer Sciences and Informatics in the field; Social Sciences - Economics and Entrepreneurship, Political Science, Education Sciences or other social sciences including interdisciplinary social sciences and military science.

Table 2

Academic staff with LCS expert status

Name	Surname	ORCID	Scientific field(s)	Election term
Andrejs	Romānovs	0000-0003-1645-2741	Natural sciences - Computer science and informatics	25.05.2023
Jānis	Grabis	0000-0003-2196-0214	Engineering and technology - Electrical engineering, electronics, information and communication technology	05.01.2025
Egils	Ginters	0000-0003-2394-6109	Engineering and technology - Electrical engineering, electronics, information and communication technology	31.03.2024
Jānis	Kampars	0000-0003-0045-5593	Natural sciences - Computer science and informatics	04.11.2023
Elīna	Gaile-Sarkane	0000-0002-7509-5273	Social sciences - Economics an entrepreneurship, Political science	18.11.2022
Nadežda	Kuņicina	0000-0002-0980-0958	Social sciences - Education science	06.01.2024
			Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Inga	Lapiņa	0000-0003-3019-2472	Social sciences - Political science	05.05.2024
			Social sciences - Economics an entrepreneurship	31.03.2024
			Social sciences - Other social sciences, including interdisciplinary social sciences and military science	22.01.2023
Sergejs	Paršutins	0000-0002-8689-3043	Engineering and technology - Electrical engineering, electronics, information and communication technology	07.10.2023
Inese	Poļaka	0000-0002-9892-7765	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

In the reporting period, changes in the composition of academic staff have been insignificant, they are mostly related to (a) academic staff being elected to other positions and (b) attraction of new academic staff for delivery of the study courses. Overall, the academic staff during the reporting period is considered stable.

There were changes in the composition of the academic staff (Fig. 2), namely, the overall number of academic staff at the programme increased from 23 educators in 2020 to 27 educators in 2022, due to the fact that 4 lecturers joined the staff to deliver three different study courses.

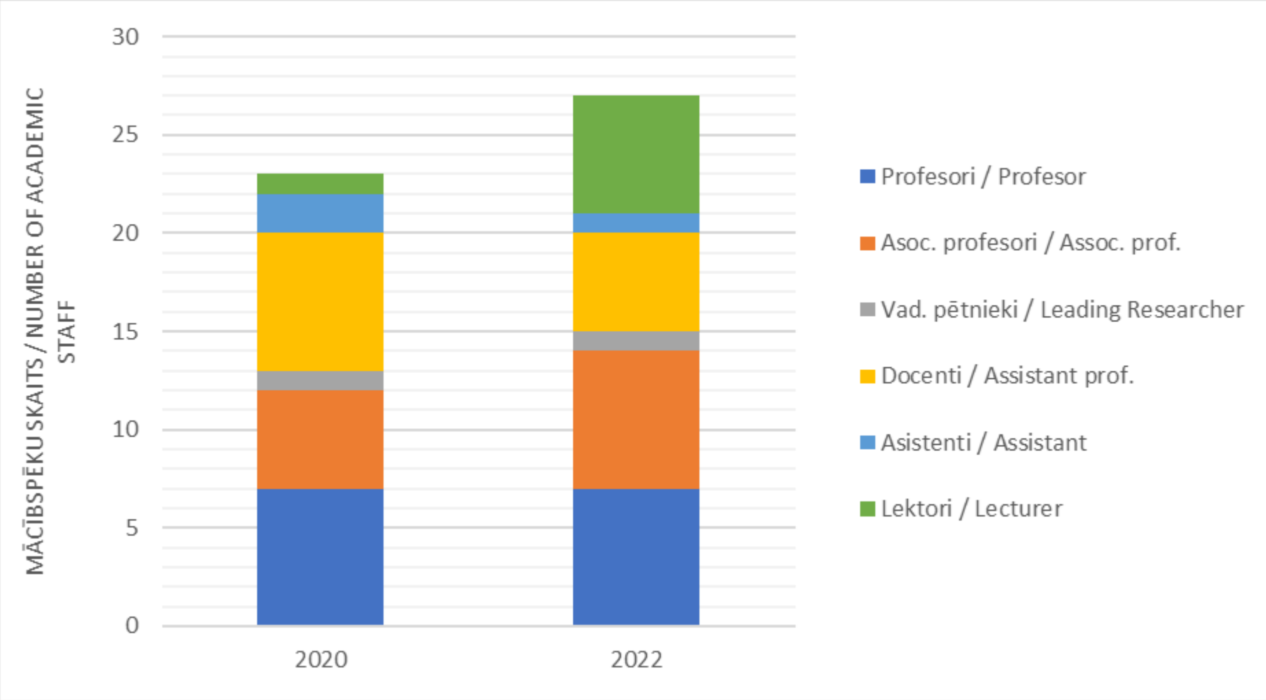


Fig. 2. Changes in the composition of academic staff in the reporting period.

Professional experience of RTU academic staff are in full compliance with the rules of implementing the study program and requirements of the regulatory enactments. Most members of RTU academic staff have a broad experience in scientific work, as well as professional experience in the industry.

The proportion of academic staff holding PhD has slightly decreased during the reporting period (Fig. 3), which is directly related to the fact that new academic staff elected as lecturers have been attracted.

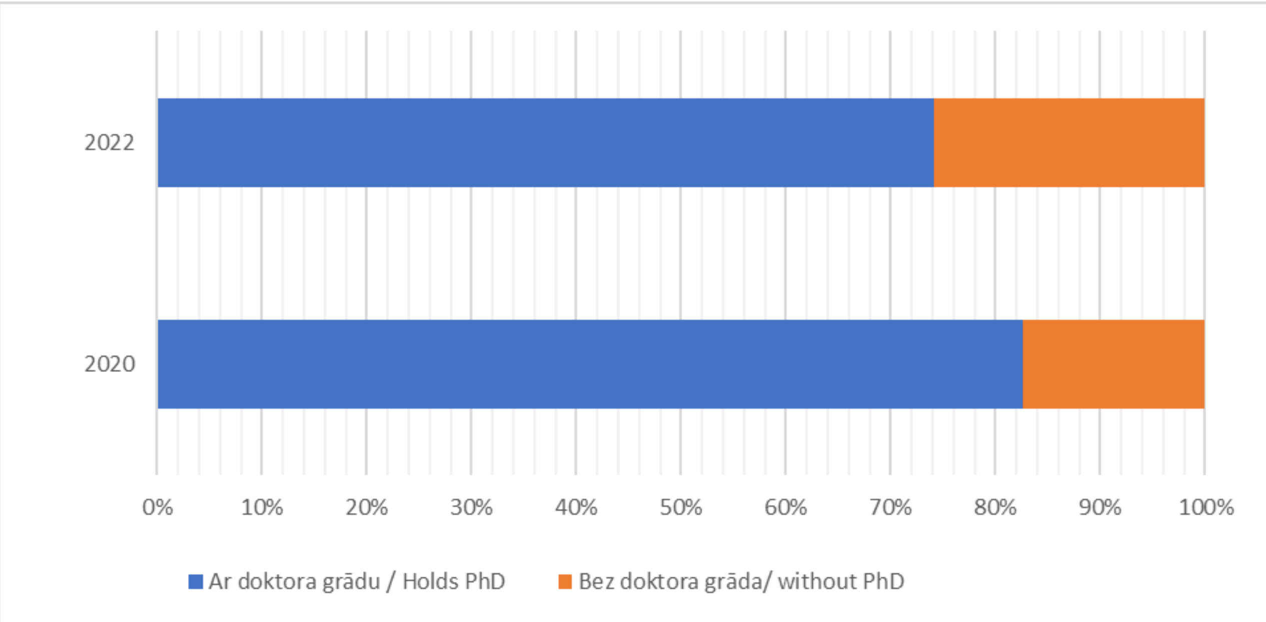


Fig.3. Proportion of academic staff holding PhD.

The academic staff distribution is appropriate for the needs of the study programme. The proportion of professors and associate professors involved in its realization is in line with that of the world's leading universities.

The changes in the academic staff during the reporting period attest that the study program has a potential for further sustainable development.

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

The educators involved in the study programme have the necessary skills in order to transfer their knowledge and experience to the students and receive feedback on their work. All members of academic staff are provided with the opportunity to advance their knowledge, take part in professional improvement courses, carrying out research and undergoing training abroad in the framework of exchange programs, take part in scientific conferences, both local and international, as well as publish their research results. Information on the participation of academic staff in conferences and their scientific publications is given in Annex 24.

In the framework of the study programme, academic staff collaborate in delivery of the content of the study courses, improvement of the study curriculum and delivery procedures, and take part in the self-assessment procedure of the study programme. The planning of the study courses provides for successive acquisition of knowledge, and the curricula of the study courses are mutually coordinated. Prior knowledge and previously acquired study courses are indicated in the description of the study courses. Upon commencing of the study program, information on delivery of the study courses and student satisfaction with the study process is collected and analyzed.

It is planned to promote cooperation among academic staff at the regular (at the beginning of the study year) joint methodological meetings of the academic staff and industry partners, where the content of the program, succession of the study courses, aims, learning outcomes and their conformity to the newest labor market requirements will be discussed. It is planned to organize a methodological meeting of the academic staff after the graduation of the first cohort to update the information of the study courses, to review and coordinate the topics, to avoid, for example, redundancy and overlapping, based on the recommendations of the program management, colleagues and students.

The study programme supports activities (according to RTU order No. 01000-1.2 / 27), when lecturers participate in the classes of other lecturers, which promotes mutual exchange of experience and collegial cooperation. These activities ar carried out with the aim to get acquainted with the lecturers' work style in general and the methods of solving relevant pedagogical tasks in classes.

The current student/academic staff ratio is lower than 3, which is related to the fact that implementation of the program started only in academic year 2021/2022.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_Diploms_DiplPielikums_LV_Diploma_DiplSupl_ENG.zip	P28_Diploms_DiplPielikums_LV_Diploma_DiplSupl_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DMK0(45526)_ProvisionalTranslationofJustification250stud_eng.pdf	P29_DMK0(45526)_AIP_atzinums250stud_kiberdr_inz.pdf
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DMK0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DMK0(45526)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_DMK0(45526)_CompliancewiththeStateEducationStandard_AkadMag_ENG.pdf	P06_3.2.1_DMK0(45526)_AtbilstibaValstsStandartam_AkadMag_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DMK0(45526)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_DMK0(45526)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DMK0(45526)_Plans_lv_Plan_eng.pdf	P09_3.2.1_DMK0(45526)_Plans_lv_Plan_eng.pdf
Descriptions of the study courses/ modules	A10_DMK0(45526)_StudyCoursesdescr_ENG.zip	P10_DMK0(45526)_StuijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc

Smart Electronic Systems (42523)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Smart Electronic Systems*
Education classification code	*42523*
Type of the study programme	*Professional bachelor study programme*
Name of the study programme director	*Dmitrijs*
Surname of the study programme director	*Pikuļins*
E-mail of the study programme director	*dmitrijs.pikulins@rtu.lv*
Title of the study programme director	*Dr.sc.ing.*
Phone of the study programme director	
Goal of the study programme	*To provide professional bachelor's level education in the field of electronics, preparing specialists who understand the development trends of the field and are able to work in the field of analysis and development of smart electronic systems, as well as to prepare for further studies in academic or professional master's study programs.*

Tasks of the study programme	*The tasks of the study programme are as follows:* *• to provide competitive education in accordance with the level of professional bachelor studies and international standards in the field of electronic systems;* *• to develop and strengthen the foundations of fundamental sciences necessary for the acquisition of theoretical study courses in the field;* *• to ensure the acquisition of basic theoretical study courses in the field of electronics at the level necessary for the acquisition of specialized study courses and innovations in the field;* *• to ensure the acquisition of specialized knowledge characteristic to the study field and the ability to apply it for the formulation and solution of tasks in various types of smart electronic systems;* *• to provide students with knowledge about the use of computer tools in the analysis, programming, modeling and design of electronic systems;* *• to ensure the development and changes of the content of the study program, implementation of the study process, scientific research work, in accordance with changes in the fields of electronic system design, international practice, science;* *• to provide students with comprehensive knowledge and develop competence in accordance with the requirements of the market for electronics engineers, preparing students for practical work in the design and maintenance of smart electronic systems;* *• to develop students' skills to obtain, select and analyze the information necessary for the implementation of professional activities, as well as to use them for decision-making and solving the problems of the respective field;* *• to provide students with the basics of professional ethics, allowing to assess the impact of professional activities on the environment and society;* *• to promote students' interest in further professional development by providing knowledge and skills for independent studies to increase their academic and professional qualifications.*

Results of the study programme	*Graduates of the study programme:* *• knows the content of the basic theoretical study courses in the field of electronics at the level necessary for the acquisition of specialized study courses and innovations in the field;* *• is able to work with scientific, technical and methodological literature available in English;* *• is able to use theoretical knowledge to formulate and solve specific tasks in the fields related to smart electronic systems;* *• is able to perform experimental data processing in the analysis of electronic circuitry and system operation features;* *• is able to develop circuits of digital, analog and RF electronic equipment and systems, make prototypes, perform their testing, analysis, and improvement;* *• is able to systematize information related to professional activities, to summarize, interpret and analyze the results of measurements and calculations, to prepare summarized reports;* *• is able to apply current technologies and software to the design process of smart electronic systems;* *• is able to design electronic equipment and systems, perform their operation modeling, management software development;* *• is able to develop printed circuit boards and corresponding technical documentation;* *• knows at the level of understanding standards and technical regulations of the electronics industry;* *• knows at the level of understanding the principles of wireless communication system design;* *• knows at the application level electrodynamics and antenna theory;* *• is familiar at the application level with analog and digital circuitry;* *• knows at the application level the theory of analog and discrete signal processing;* *• knows at the application level the programming of microcontrollers, programmable logic circuits in high-level languages ;* *• understands the importance of lifelong learning, is able to plan and implement their professional development.*
Final examination upon the completion of the study programme	*The state examination, where the elaboration and defence of a bachelor's thesis including a project is a constituent part of this examination in a public session.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education*

Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional bachelor's degree in electrical science*
Qualification to be obtained (in english)	*Electronics Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*160*
Admission requirements (in English)	*General or vocational secondary education and English language proficiency equivalent to at least CEFR B2 level*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Professional bachelor's degree in electrical science*
Qualification to be obtained (in english)	*Electronics Engineer*

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The professional Bachelor study programme in the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science (from now on - the Study Programme) has been implemented by Riga Technical University (RTU) since the year 2021 under the code ECV0 and the title "Smart electronic systems".

The programme was developed to replace the academic Bachelor study programme “Electronics and mobile communications” (code EBM0), considering the recommendations by the preceding accreditation commission. The duration of the academic study programme was 3 years. Now, as the result of implemented modifications, the duration of the new professional Bachelor study programme is 4 years from the year 2021. The volume of the academic study programme was 120 Credit Points (from now on - CP). The volume of the professional programme is 160 CP. The graduation paper amounts to 12 CP, and the practical placement amounts to 20 CP.

The degree to be conferred after completing the preceding study programme was the Academic Bachelor's Degree of Engineering Science in Electrical Science, and now the professional Bachelor's Degree in Electrical Engineering and the professional qualification of Electronics Engineer is conferred to graduates. The programme is implemented as full-time studies. According to the standard schedule of RTU, each academic year consists of 2 semesters; each semester lasts for 20 weeks - 16 study weeks and 4 weeks of exam sessions. The study programme is implemented in Riga at RTU Institute of Radioelectronics in Latvian and English.

The programme was substantially modified, and a new programme was developed since the preceding accreditation of the study field in compliance with recommendations.

1. The position of the Director of Study Programme is now taken by Assoc. professor Dmitrijs Pikulins who has appropriate qualifications and experience in the development of the content of academic study programmes;

2. The content of the study programme, the title and the code, the volume of CP, the duration and the degree to be conferred have been modified.

3. The study programme was substantially modified by adding professional field-specific study courses, providing specialisation in the following four fields: smart embedded systems, signal processing and wireless communication systems, analog and RF equipment and systems, and electronic hardware design.

4. The study programme is currently only implemented as full-time on-site studies.

5. The composition of the academic staff has changed.

Within the academic programme, compulsory study courses in Part A were provided in the volume of 82 CP; compulsory elective study courses in Part B were provided in the volume of 35 CP, of which professional field-specific study courses accounted for 30 CP, humanities and social study courses for 2CP, languages for 3 CP; free elective study courses accounted for 4CP and the final examination - the Bachelor thesis accounted for 10 CP. In the developed professional Bachelor study programme, 84 CP are provided for compulsory study courses (15CP for general education study courses, 38 CP for the field-specific theoretical basic and IT study courses and 31 CP for the field-specific professional study courses); of the total volume of 38 CP of compulsory elective study courses, the field-specific study courses account for 30 CP, humanities and social sciences study courses for 4 CP and languages for 4 CP; the free elective study courses account for 4 CP, the practical placement for 20 CP and the Bachelor thesis including project for 12 CP.

The professional Bachelor study programme was developed in cooperation with the electronics industry representatives and with their active participation. RTU academic staff with practical experience in the industry is involved in developing and providing the programme. The current content and analysis of the study programme are presented in Section 3.2.1. The changes and analysis of the academic staff involved in the implementation of the programme are presented in Section 3.4.2

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

By completing the professional Bachelor study programme “Smart electronic systems”, the professional bachelor's degree in electrical engineering and qualification of electronics engineer is conferred to graduates. The programme provides training of experts in the development and research of modern technological solutions for the Latvian and global labour market able to create innovative products by performing programming of smart embedded systems, design of wireless communication systems, development of mobile applications, etc.

The content and implementation of the study program corresponds to code 42523:

42 – The study program "Smart electronic systems" provides second-level professional higher education - prof. bachelor's degree; students are admitted after general or vocational secondary education; the duration of studies in full-time studies is 4 years.

523 – > Engineering, production and construction >Engineering and technology> Electronics and automation

The content of the study program corresponds to "Electronics and Automation", including analog and digital electronics, embedded systems (MCU, FPGA, etc.), signal processing, equipment control and process automation.

The duration and extent of the implementation of the study program is determined by Cabinet of Ministers Regulation No. 512: Regulations on the state standard of second-level professional higher education.

General or vocational secondary education is a requirement for applying for studies. The duration of studies is 4 years, and the volume of study courses to be completed amounts to 160 CP.

The title of the study programme “Smart electronic systems” perfectly conforms with the field of Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science, as electronics is included in the title of the field as its indispensable part, and smart systems combine the application of information and communication technologies, because modern smart systems cannot exist without information transmission and processing.

The aim of the programme is to provide professional bachelor's level education in the field of electronics, preparing specialists who understand the development trends of the field and are able to work in the field of analysis and development of smart electronic systems, as well as to prepare for further studies in academic or professional master's study programmes.

The tasks of the study programme are as follows:

- to provide competitive education in accordance with the level of professional bachelor studies and international standards in the field of electronic systems;
- to develop and strengthen the foundations of fundamental sciences necessary for the acquisition of theoretical study courses in the field;
- to ensure the acquisition of basic theoretical study courses in the field of electronics at the level necessary for the acquisition of specialised study courses and innovations in the field;
- to ensure the acquisition of specialised knowledge characteristic to the study field and the ability to apply it for the formulation and solution of tasks in various types of smart electronic systems;
- to provide students with knowledge about the use of computer tools in the analysis, programming, modelling and design of electronic systems;
- to ensure the development and changes of the content of the study programme, implementation of the study process, and scientific research work, in accordance with changes in the fields of electronic system design, international practice, science;
- to provide students with comprehensive knowledge and develop competence in accordance with the requirements of the market for electronics engineers, preparing students for practical work in the design and maintenance of smart electronic systems;
- to develop students' skills to obtain, select and analyse the information necessary for the implementation of professional activities, as well as to use them for decision-making and solving the problems of the respective field;
- to provide students with the basics of professional ethics, allowing to assess the impact of professional activities on the environment and society;
- to promote students' interest in further professional development by providing knowledge and skills for independent studies to increase their academic and professional qualifications.

Graduate of the study programme:

- knows the content of the basic theoretical study courses in the field of electronics at the level necessary for the acquisition of specialised study courses and innovations in the field;
- is able to work with scientific, technical and methodological literature available in English;
- is able to use theoretical knowledge to formulate and solve specific tasks in the fields related to smart electronic systems;
- is able to perform experimental data processing in the analysis of electronic circuitry and system operation features;
- is able to develop circuits of digital, analog and RF electronic equipment and systems, make prototypes, perform their testing, analysis, and improvement;
- is able to systematise information related to professional activities, to summarise, interpret and analyse the results of measurements and calculations, to prepare summarised reports;

- is able to apply current technologies and software to the design process of smart electronic systems;
- is able to design electronic equipment and systems, perform their operation modelling, management software development;
- is able to develop printed circuit boards and corresponding technical documentation;
- knows at the level of understanding standards and technical regulations of the electronics industry;
- knows at the level of understanding the principles of wireless communication system design;
- knows at the application level electrodynamics and antenna theory;
- is familiar at the application level with analog and digital circuitry;
- knows at the application level the theory of analog and discrete signal processing;
- knows at the application level the programming of microcontrollers, programmable logic circuits in high-level languages;
- understands the importance of lifelong learning, is able to plan and implement their professional development.

Thus, the graduate’s knowledge, competencies and skills comply with the professional standard of the electronics engineer who is involved in planning, performing and supervising development, testing, maintenance, repair and upgrade of electronic devices and systems; defines and organises technological processes of productions in compliance with technical documents, standards and quality management system; develops electronic devices, systems and participates in development projects, plans and monitors the process of study of the market needs and production possibilities.

Among the possible practical placement providers for students and employers there are A/S “SAF Tehnika”, SIA “Mikrotīkls”, VAS “Latvijas Valsts Radio un Televīzijas Centrs”, SIA “Lattelekom”, SIA “TET", SIA ”Latvijas Mobilais Telefons", SIA “Tele2”, VAS “Elektroniskie sakari”, A/S “Alfa”, A/S “HansaMatrix”, SIA “HansaMatrix Innovation", “Accenture” Latvijas filiāle, SIA “UAVFactory”, SIA “Citrus Solutions”, A/S “Draugiem Group”, SIA “Intelligent Systems”, SIA “AERONES", SIA “Vizulo”, SIA “Regula Baltija”, SIA “Baltic Scientific Instruments" etc. Graduates also have open possibilities for creative work in developing technology-focused start-up companies.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The application of electronic devices is rapidly increasing in all industries. Therefore, there is a high demand for experts with good knowledge in basic STEM (Science, Technology, Engineering and Mathematics) study courses and the basis of the electronics industry (circuits, signals, electronic devices, electrodynamics, etc.), who already possess the working experience and specialisation in particular areas. This can only be provided by professional study programmes presenting an opportunity to specialise in a specific area and undergo practical placement.

All the world is experiencing digitalisation in all areas. During the next planning period of the European Union (2021–2027) it is planned to invest 9.2 billion Euro in the Digital Europe programme, and 2.5 billion Euro of this amount will be invested in the development of artificial intelligence. This development aspect is essential in smart electronic systems.

Nowadays, electronic functional units are integrated into a broad range of commonly used devices (mobile telephones, cars, video cameras, etc.) and in the industry (the Internet of Things, robots, etc.). The new communication technologies (5G and 6G in the future) provide efficient connection to the Internet by using the microwave range and state-of-art signal coding and transmission methods. This means that a modern electronics engineer should possess knowledge and skills in all the above fields.

The demand for industry experts increases continuously, and higher education establishments play a decisive role. It is necessary to assess the perspective of the current study programmes and create new study programmes to train the young experts to understand new situations and operate within the environment of the leading global companies.

The modular professional Bachelor study programme “Smart electronic systems” has been developed in response to industry development trends, employers' requirements, and the Smart Specialisation Strategy set in Latvia.

It is a derived goal of the Study Programme to contribute to the development of the Latvian economy by considerably improving the content and the quality of the higher education in the field of electronics by eliminating the isolation of the higher education and insufficient contribution of universities in satisfying the needs of the local and international labour market.

The employment of the graduates of the study programme is provided by the companies of the Latvian Information and Communication Technology industry (ICT), for example: AS “SAF Tehnika”, SIA “Mikrotīkls”, VAS “Latvijas Valsts Radio un Televīzijas Centrs”, SIA “Lattelekom”, SIA “TET", SIA ”Latvijas Mobilais Telefons", SIA “Tele2”, VAS “Elektroniskie sakari”, AS “Alfa”, AS “HansaMatrix”, SIA “HansaMatrix Innovation", Accenture Latvijas filiāle, SIA “UAVFactory”, SIA “Citrus Solutions”, AS “Draugiem Group”, SIA “Intelligent Systems”, SIA “AERONES", SIA “Vizulo”, SIA “Regula Baltija”, SIA “Baltic Scientific Instruments" etc.

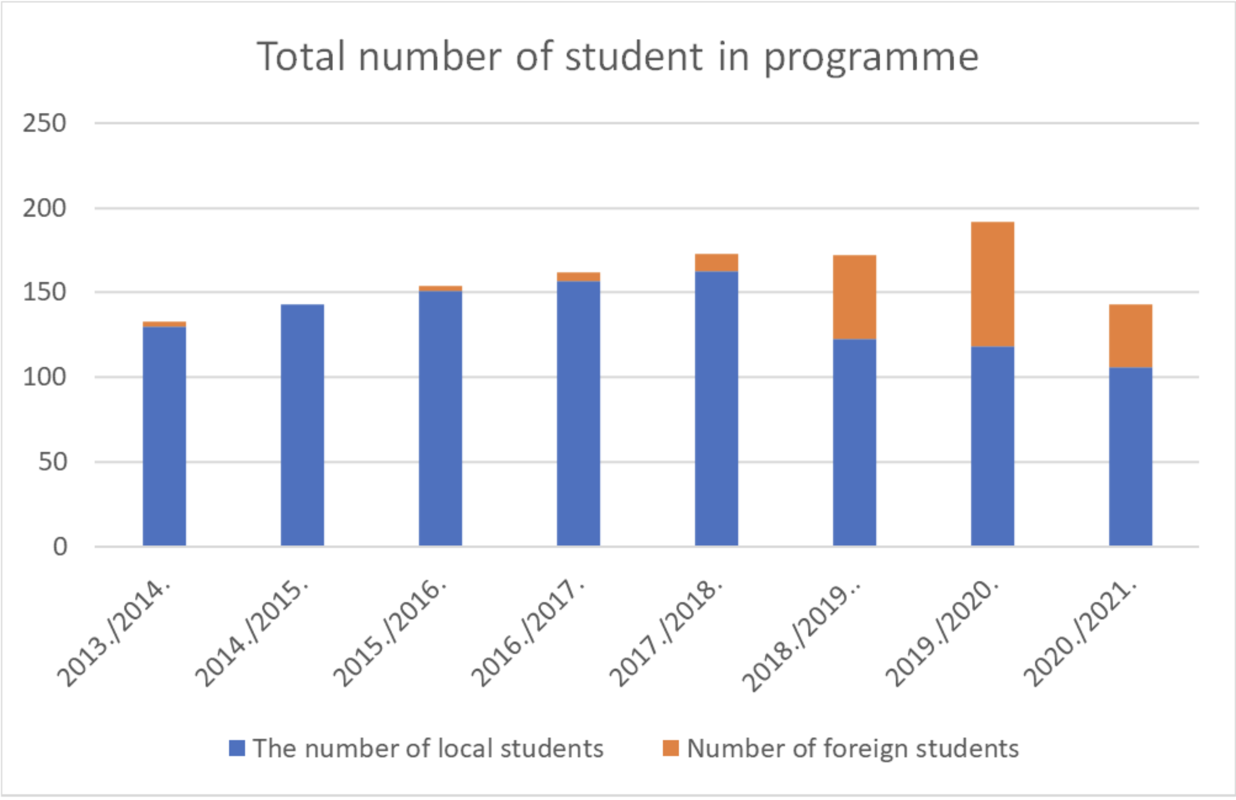
Development and implementation of the study programme is based on the RTU Strategy 2022-2025 focused on implementing the study process based on science, innovations and in cooperation with the industry providing training of the experts needed for the Latvian national economy, thus serving as the basis of the sustainable development of Latvia.

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

Annex P5 provides detailed data on students during the recent years: the total number, split per semester, languages of instruction, and a number of exmatriculated students. The available data are analysed here to identify the changes in the number of students and explain any found trends.

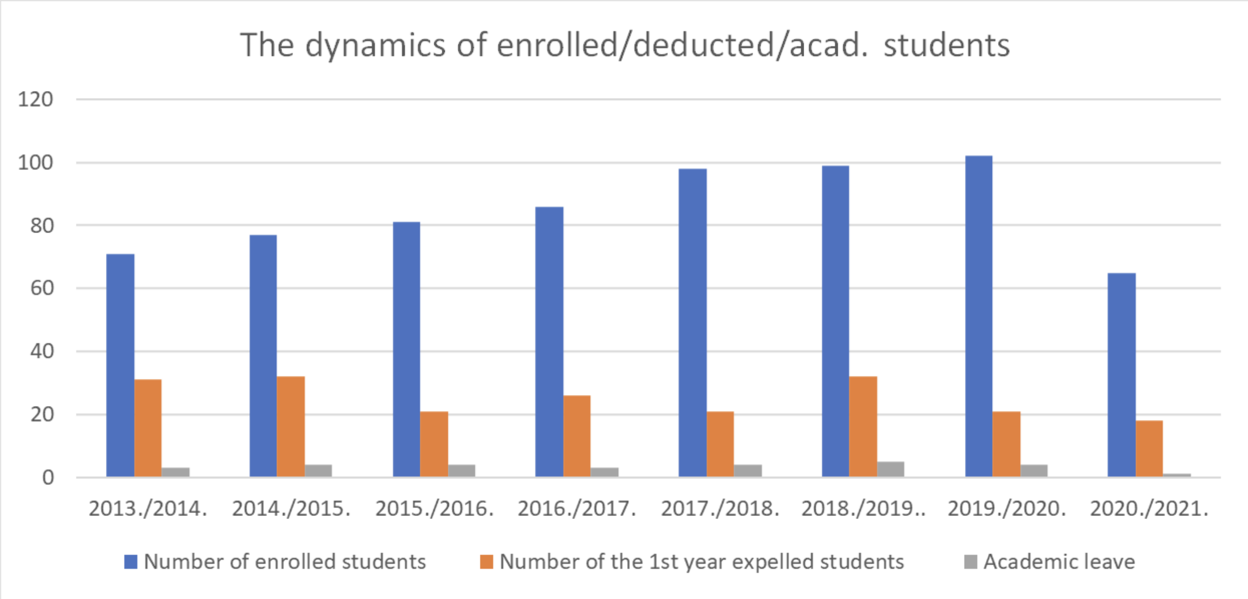
Note: The new professional Bachelor study programme “Smart electronic systems” was developed on the basis of the programme “Electronics” whose title was later changed to “Electronics and mobile communications". The first students were enrolled in the new programme in the academic year 2021/2022. Thus, the data from the preceding programmes are used for this analysis.

The overall changes in the number of students allow concluding that the number of students in the programme has been increasing since 2013. Initially, a small number of international students were enrolled in the programme. However, the change of the programme content and title to “Electronics and mobile communications” allowed attract an increasing number of foreign students to the programme. A decrease in the number of students has only been seen in the academic year 2020/2021, when fewer local and international students were enrolled due to the COVID-19 pandemic. Some international students left for their home countries and terminated their studies at RTU.

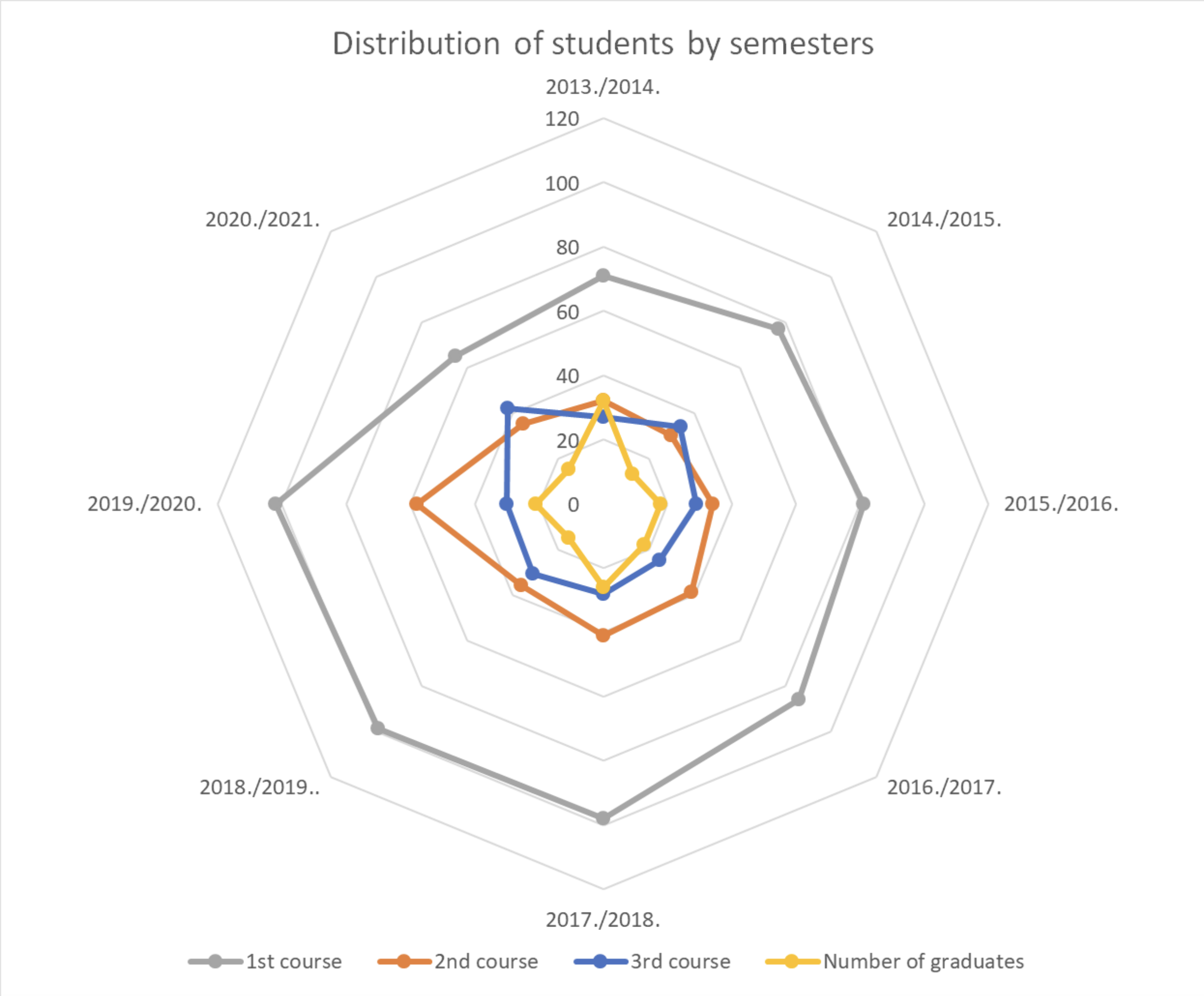


The data presented in the following graph demonstrate a stable increase in the number of enrolled students up to the academic year 2019/2020 (including). However, fewer students were enrolled in the academic year 2020/202: graduates from schools abroad were unwilling or could not come to study in Latvia. A part of graduates from Latvian schools decided to wait until on-site classes can be resumed in Latvia.

The graph presents the changes in the number of exmatriculated students. Initially (the academic year 2013/2014) the number of exmattriculated students during the 1st study year was relatively high compared to the number of enrolled students, reaching even 43%, which gradually decreased and got stable within the range of 25-30%. The decrease of exmatriculated students is related to the more active involvement of academic staff and specially assigned mentors in providing support to students, solutions to current issues and encouragement of students.



The last graph presents the split of students per semester and the number of students to whom a degree has been conferred. It can be seen that the number of the 1st year students has been increasing every year (except for the academic year 2019/2020 due to COVID-19 pandemic), which indicates a stable interest of school students in the study programme. It can also be seen that the highest number of exmatriculated students refers to the 1st study year, later the number of students is stable and there is a minor decrease thereof. It can also be seen that not all the students of the 3rd year receive the degree (at least, in the same year). This can be explained by the fact that students' knowledge and skills were sufficiently high during the last study year to start working. The best 3rd-year students of the study programme are offered special employment conditions by the Institute of Electronics and Computer Science (involving them in research projects) and SIA Hanza Matrix (by providing scholarships). Starting employment at the industry companies does not allow students to focus on developing the graduation paper during the last semesters, and students choose to use academic leaves or are exmatriculated.



The data analysis allows drawing the overall conclusion that there is a positive trend of increasing the number of students within the study programme, which refers to both local and international students. This conforms to the general development trend of the electronics industry and a stable increase in demand for the industry experts in the labour market. The number of students indicates a stable positive trend attesting to the correctness of the development strategy selected by the programme management and allowing planning of further programme development.

3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation

between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

The professional Bachelor study programme “Smart electronic systems” is implemented in the form of lectures, practical and laboratory classes, trips to companies, and self-studies by learning the basics of electronics and the details of this industry, the link with other industries of the national economy.

The content of the study programme conforms to the requirements of laws and regulations. It has been developed in compliance with the conditions defined by the decision of the RTU Senate “Unified requirements for study programmes". The study courses included in the professional Bachelor study programme are divided as follows:

- Part A - compulsory study courses providing an understanding of the essence of engineering processes, their structure and elements, as well as regularities;
- Part B - compulsory elective study courses - field-specific study courses, which are divided into the following parts:

  - B1 – professional field-specific study courses - provide knowledge of the evaluation methods of engineering systems of smart electronic systems, optimisation opportunities, teach to understand the development of the national economy within the scope of compliance with the European laws and regulations, to understand the sustainable development principles, the principles of development of scientific research projects, etc.;
  - B2 – humanities and social study courses - demonstration of the interdisciplinary nature of the electronics industry;
  - B6 – languages - development of the students’ ability to use the scientific and methodology sources available in
English;

- Part C - free elective study courses - allow students to supplement their knowledge and gain practical work skills. Within the scope of free elective study courses, students can complete any study courses of the Bachelor level offered by RTU and other accredited Latvian universities;
- Part D - practical placement – provides the practical work experience in a company or organisation of the electronics profile outside RTU necessary for students to obtain the professional qualification.
- Part E - the Bachelor thesis development completes the study programme with a design part and its public presentation to the state examination commission.

No	Code	Name	Credit points
A		Compulsory Study Courses	84.0
A1		General Education Study Courses	15.0

1	RDE710	Introduction to Electronics and Telecommunications Branch	4.0
2	SDD700	Innovative Product Development and Entrepreneurship	6.0
3	REA708	Research Seminars in the Field of Electronics	2.0
4	ICA105	Civil Defence	1.0
5	IDA700	Basics of Labour Protection	1.0
6	VAS038	Environment and Climate Roadmap	1.0
A.2		Field-Specific Theoretical Basic and IT Study Courses	38.0
1	DMF101	Mathematics	9.0
2	DIM205	Supplementary Mathematics (for electrical engineering)	2.0
3	DMS212	Probability Theory and Mathematical Statistics	2.0
4	MFA101	Physics	6.0
5	REA103	Fundamentals of Materials Science	2.0
6	RTR207	Computerization of Mathematical Tasks in Electrical Engineering	3.0
7	RTR805	Fundamentals of DC Circuits	2.0
8	RAE261	Digital Electronics and Computer Architecture	3.0
9	RTR806	Fundamentals of AC Circuits	3.0
10	RRE102	Electricity and Magnetism	2.0
11	RTR807	Circuit Theory (special course)	4.0
A.3		Field-Specific Professional Study Courses	31.0
		Smart Embedded Systems	
1	REA713	Embedded Systems Architecture and Peripherals	3.0
2	REA714	Embedded Systems Architecture and Peripherals (study project)	2.0
		Signal Processing and Wireless Communication Systems	
1	RTR822	Signal Theory	3.0

2	RTR823	Signal Theory (study project)	2.0
3	RRI324	Digital Signal Processing	2.0
4	RRI713	Digital Signal Processing (study project)	2.0
		Analog and RF Equipment and Systems	
1	REA204	Electron Devices	3.0
2	REA709	Active Electronic Systems	3.0
3	RTR707	Analogue Electronics	5.0
4	RTR820	Electrodynamics and RF Devices	3.0
		Electronic Hardware Design	
1	RTR701	Laboratory Exercises in Electronics	3.0
B		Compulsory Elective Study Courses	38.0
B1		Field-Specific Study Courses	30.0
		Smart Embedded Systems	
1	EAP301	Electronic Control System Design	4.0
2	REA711	Fundamentals of Digital Electronic Systems Design using HDL	3.0
3	REA712	Fundamentals of Digital Electronic Systems Design using HDL (study project)	2.0
4	TRT461	The C Programming Language	2.0
5	RAE362	Digital Devices and Systems	3.0
6	RTR105	Computer Studies (basic course)	3.0
7	DST712	Internet of Things Technologies	2.0
		Signal Processing and Wireless Communication Systems	
1	RTR800	Fundamentals of Smart Radio	3.0
2	RTR825	Fundamentals of Smart Radio (study project)	2.0
3	RDE706	Transmission Systems	6.0

		Analog and RF Equipment and Systems	
1	RRI349	Analogue and Digital Integrated Circuits	3.0
2	RTR821	Antenna Design	3.0
3	RTR824	Antenna Design (study project)	2.0
		Electronic Hardware Design	
1	RDE709	Electrical Measurements in Telecommunications	4.0
2	RRI405	Electroacoustics	2.0
3	REA710	Design of Printed Circuit Boards	4.0
4	RRI708	Design and Documentation of Electronic Equipment	3.0
5	REA502	Electromagnetic Compatibility: Components and Applications	3.0
B2		Humanities and Social Sciences Study Courses	4.0
1	HSP380	United Europe and Latvia	2.0
2	HFL336	Basic Ethics	2.0
3	HSP379	Political System of Latvia	2.0
4	IRO415	Organization of Production	2.0
5	HSP375	Sociology of Management	2.0
B6		Languages	4.0
1	HVD101	The English Language	2.0
2	HVD415	The German Language	4.0
3	HVD216	The English Language	2.0
4	VSL711	Latvian for Foreign Students	1.0
5	HVD104	The English Language	3.0
C		Free Elective Study Courses	6.0
D		Practical Placement	20.0
1	RRI712	Practical Placement	20.0

E		Final Examination	12.0
1	RTR711	Bachelor Thesis Including Project	12.0
			160

The study programme amounts to 160 CP. The duration of the full-time professional Bachelor studies is 4 years divided into 8 study semesters, during which compulsory (84 CP), compulsory elective (38 CP) and free elective (6 CP) study courses, the practical placement (20 CP) need to be completed. The Bachelor Thesis with a design part (12 CP) has to be developed. The study programme is available to general or vocational secondary education applicants.

The professional field-specific study courses included in the study programme are additionally merged into specialisation modules: smart embedded systems, signal processing and wireless communication systems, analog and RF equipment and systems, and electronic hardware design (horizontal specialisation), thus providing integrity to the study programme. Inclusion of the study courses comprised of modules in the part of compulsory study courses allows students to gain basic knowledge in several fields of smart electronic systems in the 1st and 2nd study years. The study courses included in the compulsory elective part allow students to gain in-depth knowledge and competencies in their selected speciality in the 3rd and 4th study year (the selection is made in the 3rd study year), thus providing systematic mastering of the speciality by selecting study courses in a substantiated and sequential manner.

Accordingly, the planning and mapping of study courses are presented in Annexes 8 and 9.

In the mapping of study courses, the study programme results are defined in compliance with the outcomes of the study programme by structuring the outcomes based on the knowledge, skills, and competencies to be acquired.

The planning of study courses is structured in study semesters and, together with the mapping, provides a clear overview of the consequence of knowledge, skills, and competencies to be acquired.

During the first and second semesters, students acquire the theoretical and practical basis for learning the courses to be provided during later semesters. Therefore the emphasis is on the introductory theoretical courses: *mathematics, physics, basics of direct current and alternate current circuits, electricity and magnetism*, *digital electronics and computer architecture, etc*. The broad course *Introduction to the Electronics and Telecommunications Branch* is offered as a general education study course, which introduces students to RTU and provides insight into the profession of the electronics engineer and comprises practical assignments for encouraging the students' interest in the industry. Also, during the first semester, within the study course *Laboratory Exercises in Electronics*, students have an opportunity to master the necessary skills for designing simple electronic schemes, testing, soldering from the very first days of studies. Students improve their foreign language knowledge during the first study year, thus developing their ability to work with technical, scientific and methodological literature available in a foreign language.

During the third and the fourth semesters, students continue studying the basic theoretical courses and some introductory courses of professional specialisation, which allows creating the basis of knowledge and skills for further selection and mastering of the specialisation. Semiconductor electronics elements are introduced to students in the study courses *Electron devices* and *Active electronic systems*. They are trained to perform measurements of electrical parameters and learn the basics of signal theory and analog electronics. Students learn to apply the modern software for engineering and simulation of electronic systems during study courses. Students learn to program microcontrollers in two sequential semesters within the study courses Electronic Control System Design and Embedded Systems Architecture and Peripherals.

During the fifth and sixth semesters, a broad range of compulsory elective courses and specialisation courses is offered to allow students to select one or several of the specialisations defined in the study programme based on the knowledge and skills mastered during preceding semesters. The outcomes of the offered study courses cover quite a broad range of knowledge and skills to be acquired by focusing mainly on the solution of the problems of electrodynamics and antennae theory, digital circuit techniques, signal processing and data transmission. Achievement of the above outcomes requires mastering additional skills to apply the specific software for the tasks of design, simulation and programming of systems. At the same time, students' competence in developing and testing various prototypes is improved.

During the sixth semester, the study course *Design and Documentation of Electronic Equipment* is offered to provide extensive knowledge on the production technologies of electronic devices, the industry standards and rules, preparation of documents, and improving the students' competence in defining technological processes. The knowledge and competencies acquired during this study course will be used in the practical placement scheduled for the 7th and 8th semesters.

During the seventh and eighth semesters, students have *the Practical Placement* amounting to 20 CP. It is provided to students in compliance with the specialisation selected during the third study year, allowing them to master necessary practical skills at the workplace. Along with internship within the study course *Research Seminars in the Field of Electronics*, students are introduced to the preparation of the graduation paper, its structure, requirements, and tools to be used during its development. During the 7th semester, students complete the study course *Innovative Product Development and Entrepreneurship*, which develops the students' creative thinking and provides necessary knowledge and skills for analysing innovation processes in electronics and telecommunications.

After the study programme, students, according to their specialisation, develop the *Bachelor Thesis Including Project,* which is publicly presented to the state examination commission.

The overall analysis of the mapping allows concluding that the outcome of the study programme is covered in a balanced way without overlapping. During the first year students acquire a particular knowledge base (by mastering relevant knowledge, skills and improving their competence). The students acquire in-depth knowledge during the following years and improve their competence in the specialisations defined within the study programme.

The annual revision of the existing mapping will be done by updating both the outcomes of the study courses and the outcomes of the study programme responding to the industry development trends and the labour market requirements.

Industry experts from numerous Latvian electronics companies were involved in the development of the study programme: SIA "HansaMatrix Innovation", AS "SAF Tehnika", SIA "Citintelly", SIA "ADI", AS "Draugiem Group", thus allowing contribution to the development of high-quality education and practical training systems into a critical knowledge and technology intense industry. Several experts have conformed that they are prepared to participate in the study process by delivering guest lectures on topical themes of the electronics industry.

Workshops with the industry representatives are scheduled now and will take place every year, thus improving the content of study courses and introducing the industry trends. Contacts are maintained with graduated and industry experts by inviting them to present guest lectures and participate in workshops with students and the academic staff, thus contributing to the development of every study course and its conformity with industry trends. Questionnaires on conformity of both study courses and the academic staff to the goals and objectives of study courses are posted on the RTU portal ORTUS every year and this helps to improve the content of every study course and the programme as a whole, as well as the level of ability and knowledge of every academic staff member.

Cooperation with the industry representatives is also envisaged during graduation papers' development and public presentation. The industry representatives will participate in the supervision of the Bachelor thesis (by proposing topics important for the industry to students), their review (by providing a conclusion regarding developed graduation papers) and evaluation (by participating in the work of the State examination commission).

In the course of implementing the study programme, its goal “to provide professional bachelor's level education in the field of electronics, preparing specialists who understand the development trends of the field and are able to work in the field of analysis and development of smart electronic systems, as well as to prepare for further studies in academic or professional master's study programs” is achieved.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

Not applicable.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

During the implementation of the study programme, the range of students and the variety of the needs is taken into account by paying special attention to the differences in preparation of international students:

- The possibility to complete study courses in various ways is provided by applying diverse teaching methods (including the remote study process by providing reading of lectures, the process of practical assignments, testing and evaluation of the independent work), thus allowing students to effectively acquire new knowledge and skills, at the same time also developing their enquiring abilities.
- The student's willingness to be independent is encouraged by allowing students to deal individually with practical assignments while providing supervision and support by the

academic staff during regular consultations.

- Considering the students' individual interests, some study assignments, for example, assignments of course papers and course projects, can be adapted to individual needs.
- High quality and practical assessment of students is provided:

  - Assessment of study outcomes at RTU is performed in compliance with the "Regulation on the Assessment of Learning Outcomes" (only in Latvian)(https://www.rtu.lv/writable/public_files/RTU_1_studiju_rezultatu_vertesanas_nolikums.pdf) and Regulations on Final Examinations at Riga Technical University (only in Latvian) (https://www.rtu.lv/writable/public_files/RTU_par_nolikuma_par_studiju_nosleguma_parbaudijumiem_rtu_apstiprinasanu_jauna_redakcija.pdf)

  - Study goals and the student's study outcomes at the end of the course are clearly defined in the course description for every study course. The requirements for successful completion of the course and the criteria for assessment of outcomes are also defined. Upon starting a study course, the professor informs students about the course requirements and assessment criteria during the first class.
  - During the study process, every student receives an individual assessment of the achieved results in a test, an exam paper, laboratory assignment, etc., either directly from the professor or within the course environment in Moodle system. If there are any questions or objections, the student can contact the professor and receive clarifications. An independent reviewer is assigned to assess more extensive volume study courses (internship, graduation papers, etc.), and a commission is set up for public presentation.
  - The final grade is based not only on the examination. Instead, students' continuous progress during the whole academic year is taken into account (tests, home assignments, laboratory assignments, etc.), thus allowing to carry out an objective assessment of the attainment of expected study outcomes by students.

- Students can provide an anonymous assessment of the relevant course following its completion by providing feedback to improve the quality of the study course, adapting the content and teaching methodologies to the students' expectations.
- Professors carry out regular electronic surveys (polling) regarding the lecture materials to assess the efficiency of mastering study courses provided remotely and in person. Surveys are not assessed by assigning a grade. Still, they allow collecting statistics about the mean level of knowledge in particular courses and provide an opportunity for the academic staff to respond fast by presenting additional materials to students to improve their knowledge of weaker concepts.

- Regular (minimum twice a year) meetings are organised for the directors of study programmes, group leaders and representatives of the students' parliament to assess the quality of the study programme.
- The teaching methods, the structure of study courses, and the assessment methods are selected by the academic staff responsible for the study course in compliance with the specifics of the content of the study course and the study programme, as well as students' needs.
- Courses and workshops on modern teaching and study methods are organised for the academic staff. Attendance of qualification improvement courses at the internal faculty events and on RTU and international levels is encouraged. RTU Centre of Academic Excellence organises academic staff improvement events at the university level. The matters of teaching methodology and the possibilities of using modern technologies for improving the study process are also discussed within the institute and at department meetings.
- Students are involved in the processes of developing new study courses and developing the

structure and content of the study programme within the scope of the faculty council and relevant working groups.

- Necessary support for integration in the study environment is provided to students within mobility programmes.
- The study program is also implemented in English, targeting international students. All study courses are provided with study materials in English. The description of each study course also indicates the literature in English available in the library. All teaching staff conducting study courses for international students have corresponding knowledge of English.

- Students receive everything they need for studies, i.e. the needed equipment, software, premises, etc.
- Within the scope of some study courses, students have an opportunity to develop practical assignments outside the RTU laboratories and needed equipment is provided to them. This approach allows students to work according to the individual working rhythm and master in-depth skills, like programming embedded systems on HDL basis, signal processing, etc. For these purposes, the study programme materials, particularly the technical equipment, are regularly supplemented by adding unique portable sets of kits and development tools.
- To develop graduation papers, students have access to many RTU laboratories and specially equipped premises where students can work independently without supervision by the academic staff.
- For more efficient development of graduation papers and receiving a higher final grade, regular workshops (minimum twice a semester) are arranged for students where they have to present the results of the development of their graduation papers. The academic staff provides comments regarding the work progress and implementation and indicates possible solutions to issues.
- Students have an opportunity to participate in extra-studies activities:

  - by contributing to the work of the self-government;
  - by providing an opportunity to students to improve their professional competencies in the Electronics Club, the Design Factory, etc.;
  - by providing possibilities to study outside lectures in the reading room of the RTU library, open 24/7.

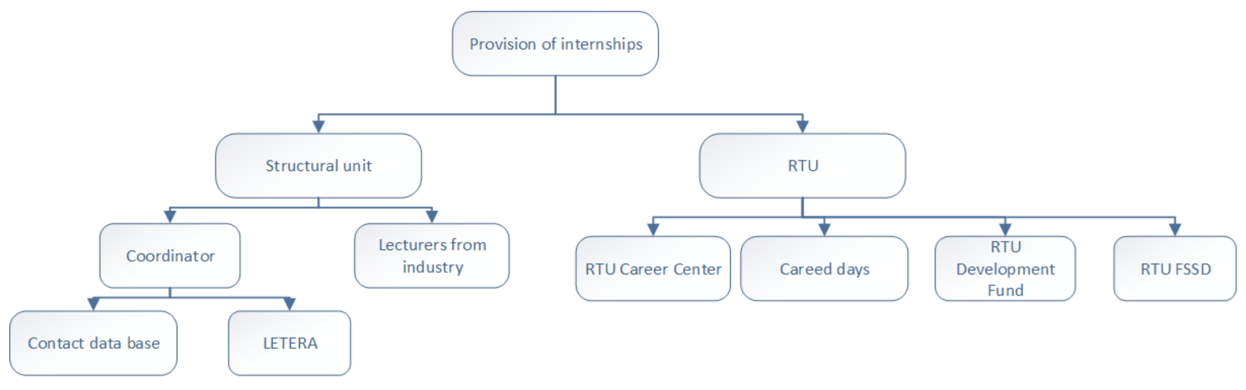
3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

After completing theoretical courses, students use practical placement to detail and strengthen their professional knowledge. The Internship aims to provide the practical work experience needed for receiving the professional qualification for the student at a company or institution of electronics profile outside RTU.

During the Internship, students get acquainted with the structure and work organisation of the internship company and the technical-economic performance. Students have an opportunity to learn the modern scientific and innovative technical solutions in smart electronic systems and get acquainted with labour safety, safety technique, environmental protection and electromagnetic compatibility standards, and their technical and organisational solutions.

The tasks of the student internships included in the study program are formulated according to the study results to be achieved in the study program.

Students present the assignments completed during the Internship in their report.



Scheme of provision of internship placements

The Internship is organised in compliance with the Senate decision on the Procedure of the organisation of the Internship at RTU. As defined in the procedure of the internship organisation, the internship coordinator in the corresponding structural unit assists students in finding an internship placement. As a result of providing students' internships at companies for many years, the list of potential industry companies and organisations, including the updated database of contacts, is developed and maintained in the structural unit.

The Latvian Electrical Engineering and Electronics Industry Association (LETERA), with approximately 95 active members registered as of the beginning of 2022 - large and small companies of the industry, also provides important support for internship placements.

For the provision of the study process of the professional program, many practising industry experts are involved as lecturers and assistant professors who have direct contact with students and offer internship placements in their companies.

If additional assistance is needed, it is possible to contact the Division of Career Support and Services where a career consultant and a project manager helps students to find internship placements and to contact them, as well as implement various events to contribute to development of career management skills, which can ensure successful results in the internship process. Once a year, the Division of Career Support and Services organises the RTU Career Day, where students can meet company representatives and speak about future opportunities. See more details about the event and participants of preceding years: http://karjera.rtu.lv/projekti/karjeras-dienas-arhivs/.

An additional resource developed since 2015 is a website where companies are invited to post their vacancies interesting for RTU students (https://ekarjera.rtu.lv/). Students can connect with the university username and follow current internships and employment opportunities in their industry.

The RTU Development Fund also supports promoting practical skills (https://www.rtu.lv/lv/attistibasfonds). During the year, several hundreds of competitions to improve practical skills are offered and organised in cooperation with companies and provide an opportunity for students to learn practical skills.

Considering that the internship is organised at later study stages, students have an additional opportunity to develop their graduation paper at the company where they have internship and continue working in the company selected for internship later.

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The development of graduation papers encourages students to participate in scientific research. Students present Bachelor thesis topics and obtained results at scientific conferences. At the RTU scientific conference of students from the study programme “Electronics and mobile communications” 9 students participated in 2018. 15 students in 2019, 6 students in 2020 and 17 students in 2021.

The first students were enrolled in the professional Bachelor study programme “Smart electronic systems” in 2021. Therefore, there are no programme graduates at the moment preparing the self-assessment report. The study programme “Smart electronic systems” was developed based on the academic Bachelor study programme “Electronics and mobile communications", therefore the graduation papers of this programme are analysed.

The topics of graduation papers from 2013 to 2021 are summarised in the tables. Graduation papers may be divided into 6 thematic fields (see the below table). Topics of graduation papers were selected under the fields of science and current projects represented by the RTU supervisors, students’ interests, and the industry companies' current challenges. From 2013 to 2021, most students of the 3rd year were employed in the companies and selected the topic of the graduation paper, its development methods, and tools in compliance with their work specifics. Therefore, it can be said that the topics of graduation papers reflect the industry development trends, and their division conforms with the priority directions selected by the companies.

Academic year 2013/2014	
Title of the Bachelor Thesis	**Thematic field**

Research of an efficient flyback power supply	Power Power supply sources, energy transmission
Battery renovation system	
Impulse charging of batteries	
Autonomous device power supply	
Reduction of electromagnetic interference in impulse supply sources	
Improvement of energy quality by combining converters	
Ensuring electromagnetic compatibility of switch-mode power supply by means of the spread spectrum method	
Programmable device for battery charging	
Digital implementation of analog music synthesiser	Electroacoustics and music generation
Data transmission utilising acoustic modems	
Transmission of several routes in wireless mesh networks	RF and wireless communication systems
Discovery of neighbouring units in wireless ad-hoc networks	
Advantages and drawbacks of femtocell technology	
Implementation of JPG image compression in MATLAB	Signal and image processing
Identification of the dielectric layer parameters utilising the interference method	Electronics elements, measurements

Academic year 2014/2015

Title of the Bachelor Thesis	Thematic field
High-quality power supplies, energy transmission for large capacity laser diodes	Power supply sources, energy transmission
Suppression of emissions caused by impulse supply sources by means of the linear regulator (LDO)	
Design of uninterrupted power supply for a protection system	
Analysis, synthesis and implementation of audio effects	Electroacoustics and music generation

Elements and operation principles of a radio frequency identification system	Signal processing and wireless communication systems
Video compression standards	Signal and image processing
Dielectric layer thickness measurement by reflectometrics method	Electronics elements, measurements
Non-destructive ice cover thickness control	
Electronic device for control of the internal parameters of a beehive and condition of the bees	Embedded systems and the Internet of Things
Applications of impulse type ultra-broadband sensors in security systems	
House automation by using a Raspberry Pi computer	
Corrector of ballistic errors of the semiconductor detection unit	
Remote research data collection and processing by using a pilotless aircraft	

Academic year 2015/2016

Title of the Bachelor Thesis	**Thematic field**
Research of losses of the step-down switching power converter	Power supply sources, energy transmission
Evaluation of acoustic echo by using adaptive filtration	Electroacoustics and music generation
Ear monitor systems in vocal music	
Active noise suppression system	
Measurement of the antenna 3D radiation diagram, data recording and processing	RF and wireless communication systems
Research of the digital radio mondiale broadcast format	
Voltage controlled filter	Signal and image processing
Survey of structures by using the earth probing systems and the wall probing radar	

Measurement of the complex dielectric permeability of multi-layer materials in the wave conductor	Electronics elements, measurements
Surface mount PCB technologies	
3-D metal printer	Embedded systems and the Internet of Things
Automated hydroponic garden system	
Sea drifter embedded data collection and storage system	
Implementation of stabilisation of quadrotor flight by using proportional-integral-diferentiating (PID) controller	
Adjustable time relay	
Tool for presenting information from CAN busbar	
Solutions of space change and object movement detection sensors	
Smart sensors for the collection of the Baltic Sea stream and wave data	

Academic year 2015/2016

Title of the Bachelor Thesis	Thematic field
Research of losses of the step-down switching power converter	Power supply sources, energy transmission
Evaluation of acoustic echo by using adaptive filtration	Electroacoustics and music generation
Ear monitor systems in vocal music	
Active noise suppression system	
Measurement of the antenna 3D radiation diagram, data recording and processing	RF and wireless communication systems
Research of the digital radio mondiale broadcast format	
Voltage controlled filter	Signal and image processing
Survey of structures by using the earth probing systems and the wall probing radar	

Measurement of the complex dielectric permeability of multi-layer materials in the wave conductor	Electronics elements, measurements
Surface mount PCB technologies	
3-D metal printer	Embedded systems and the Internet of Things
Automated hydroponic garden system	
Sea drifter embedded data collection and storage system	
Implementation of stabilisation of quadrotor flight by using proportional-integral-diferentiating (PID) controller	
Adjustable time relay	
Tool for presenting information from CAN busbar	
Solutions of space change and object movement detection sensors	
Smart sensors for the collection of the Baltic Sea stream and wave data	

Academic year 2017/2018

Title of the Bachelor Thesis	**Thematic field**
Audio signal processing by using the computer graphic card	Electroacoustics and music generation
Wireless power transmission system	RF and wireless communication systems
5G mobile communication technologies	
Optimisation of antennae parameters	
Research of optic focus measurement and calibration methods for the multi-plane imaging system	Signal and image processing
ToF sensor and chamber data processing and merging for the scene 3D reconstruction and presentation in the volumetric display	
Development of the ToF sensor-based endoscopic probe prototype	
Generation and selection of chaotic sequences for asynchronous DS-CDMA system	
Signal survey for RF wireless energy transformation	

Meter of the V-A characteristic of active elements	Electronics elements, measurements
CMOS digital – analog converter in controlled resistance mode	
Flat–wave diffraction on the layered cylinder. Measurement of dielectric permeability of liquids	
Application of underwater acoustic transmitter in fishing and fish breeding	
Measurement of varicap parameters	
Survey of the possibilities of implementation of wireless sensor networks	Embedded systems and the Internet of Things
Applications of a wireless sensor network in detecting the structure deformations	
Implementation of the Doppler radar signal processor algorithm in a microcontroller	
Energy-efficient data transmission on wireless sensor networks	
Air quality sensor for the intelligent home ventilation control	
LPWAN technology research and comparison for IoT applications	
Home sensor control system	
Development of a miniature recorder by using specialised integrated circuit	
Analysis of the application of PIR type movement sensors in a car anti-theft system	
Measurement of the filling of a drying tank	
RGB LED programmable universal controller	
Smart home climate control system	

Academic year 2018/2019

Title of the Bachelor Thesis	**Thematic field**

4-Coil wireless power transmission system	Power supply sources, energy transmission
Development and research of a step-up voltage converter	
Development and research of a universal power supply source	
Dual-radio channel, based on the principle of radio spread-spectrum technology	RF and wireless communication systems
Device-device communication research in 5G networks	
Application of the chaos generator in long-range wireless sensor networks	
Latency in data processing networks and related challenges in the next generation communication systems	
Next-generation wireless communication systems	
Application of filed-programmable gate arrays for obtaining and modification of camera images	Signal and image processing
Measurement of mutual inductivity between two inductively coupled coils	Electronics elements, measurements
Dependence of the parameters of the metal mass detector on the parameters of the inductive loop	
Development and research of current meter magnetoresistive sensors	
Optic fibre connection and CATV testing device	
Provision of long-term operation of the narrowband Internet of Things (NB-IoT) device	Embedded systems and the Internet of Things
Data transmission security analysis of the narrowband Internet of Things (NB-IoT) devices	
Power supply control systems of portable IoT devices	
Movement accuracy control system for workbenches with digital programme management	

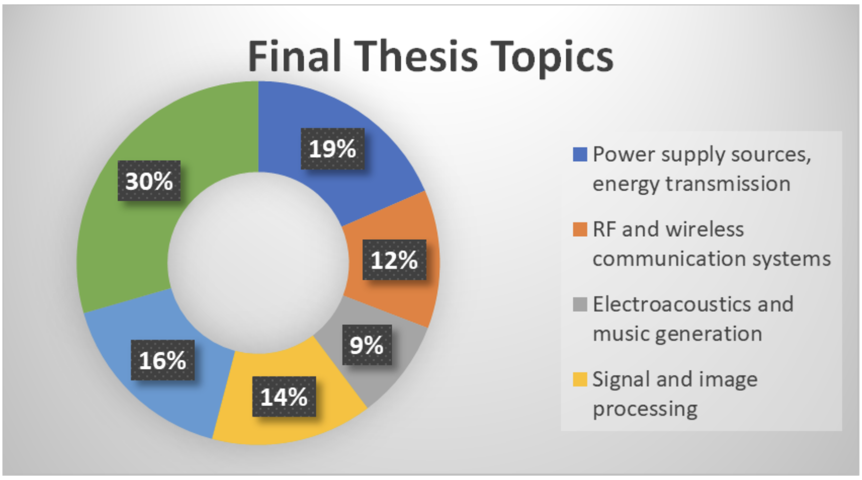
Academic year 2019/2020

Title of the Bachelor Thesis	**Thematic field**

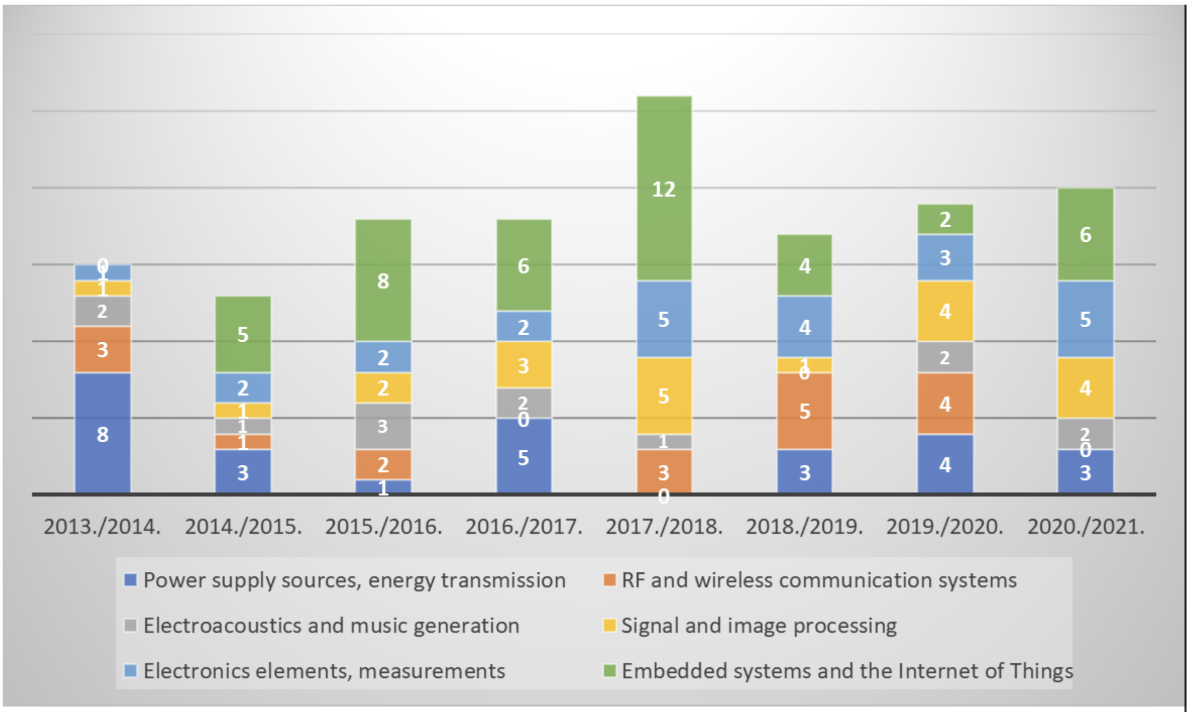
A modular power supply unit with several outlets for devices with USB supply	Power supply sources, energy transmission
Development and research of a low-capacity battery charger	
Inductive-resonance wireless power transmission system with two operational frequencies	
Wireless power transmission in liquids	
Chaos frequency manipulation for wireless sensor networks	RF and wireless communication systems
Chaos manipulation, based on the application of the quadrature modulation	
Application of the R-C generator in the development of chaotic communication systems	
Planning of the frequency range in 4G and 5G mobile communication networks	
Audio effect based on the interaction of the spring reverberator oscillations and changing light	Electroacoustics and music generation
Modular synthesiser for beginners	
Application of speed measurements for correction of image movement caused distortions	Signal and image processing
Identification of the concrete humidity by using an impulse radar	
Humidity monitoring in concrete by using rod probes	
Face detection acceleration by FPGA	
Pulse analyser	Electronics elements, measurements
Rotation speed measurement methods	
Development of power amplifier compatible with “Analog Discovery 2”	
Development of an embedded system with uW consumption for the Internet of Things applications	Embedded systems and the Internet of Things
Analysis of resource utilisation in FPGA	
Academic year 2020/2021	

Title of the Bachelor Thesis	Thematic field
Research on the efficiency of RF-DC transmission in wireless energy transmission	Power supply sources, energy transmission
Development and research of a wireless battery charging system	
Direct voltage converter with input voltage with any polarity	
Movement controlled audio signal range deviation	Electroacoustics and music generation
Noise generator for a modular synthesiser	
Implementation of compressing retrieval reconstruction algorithm FPGA	Signal and image processing
Machine learning-based automated recognition of bird species by using vocalisation of birds	
User interface graphics rendering with FPGA	
Research of the problems of chaos generator computer simulation	
Time reflectometry method for measuring timber humidity	Electronics elements, measurements
Measurement of humidity of solid materials surface	
Development and research of a digital direct voltage voltmeter	
Digital meter of mutual inductivity between two coils	
Identification of the shape of two-dimensional dielectric objects with known dielectric permeability from the field division in the far area using methods of solution of the reverse diffraction task	
Fast transmission SerDes communication on FPGA base	Embedded systems and the Internet of Things
Smart pot for citrus plants	
Control of a drone by using a microcontroller	
Improvements in the control automation of shutters of fire extinguishing valves	
Research of energy consumption of the NB-IoT module under various operational modes	
Contactless synchronous engine operation and control	

Based on the titles, it can be seen that the themes of the graduation papers have changed over the years. This is related to both the industry development trends and the gradual change in the composition of the academic staff involved in the programme. In recent years an increasingly high number of graduation papers were focused on the development of embedded systems, signal processing and RF and wireless communication systems. This corresponds to the specialisations or modules introduced in the professional Bachelor study programme “Smart electronic systems”: smart embedded systems, signal processing and wireless communication systems, analog and RF equipment and systems, and electronic hardware design (horizontal specialisation).

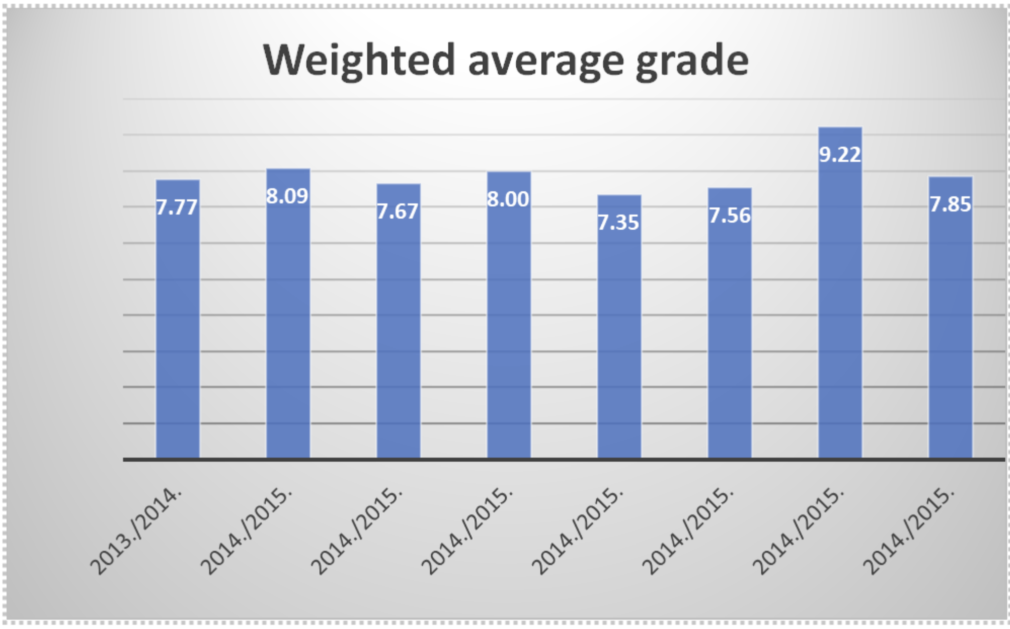


Split of the topics of graduation papers per thematic fields (2013-2021).



Changes in the topics of graduation papers per years

Summary of the weighted average grade data reveals that it is around 7.94, which is an overall indication of a high level of preparation for graduation papers.



Changes of the weighted average grade

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

For the implementation of the study programme, there are available centralised resources, for example, the RTU scientific library and electronic storage subscriptions and specific resources supplementing the centralised resources. Centralised resources are described in detail in the relevant sections of the resources of the study field. This section describes the specific resources for implementing the professional Bachelor study programme “Smart electronic systems".

It is envisaged to implement the study programme mainly in the RTU Faculty of Electronics and Telecommunications (ETF) premises. Renovation works were performed at ETF. Therefore, the faculty conforms to international standards for providing a high-quality study process. Equipment of lecture rooms and training laboratories is continuously updated by following the industry development trends.

The academic staff of ETF from the below listed structural units is involved in the implementation of professional study courses of the study programme in compliance with specialisations:

- Institute of Radioelectronics ;

- Departments of basic electronics;
- Department of electronic devices;
- Department of radio devices;
- Institute of Telecommunications;
- Department of transmission systems;
- Department of telecommunication networks;
- Department of telematics and transport electronic systems.

Implementation of general education, humanities and the industry theoretical basic courses of the study programme is provided by:

- Department of labour and civil defence;
- Department of engineering mathematics;
- Department of the probability theory and mathematical statistics;
- Department of optics;
- Department of the artificial intelligence and system engineering;
- Department of computer networks and system technology;
- Department of social sciences;
- Department of languages of special use.

Relevant structural units provide development and improvement of the materials of study courses, provision of lectures, supervision of laboratory assignments and practical classes and other study and methodological activities. The teaching staff of ETF is also in charge of supervision and public presentation of graduation papers and provision of Internships.

Also, the common RTU assistant staff is available to implement the study program and provide the functioning of the infrastructure. Implementation and maintenance of the study program are ensured by the administrative staff consisting of the study office administrator, records keeper and technical staff. Management of international students and coordination of the study work is done by the RTU International Cooperation and Foreign Students Department.

For the implementation of the study programme “Smart electronic systems” both literature sources available in the library, as well as increasingly frequently used electronic books from the above referred electronic resources are used.

Books are searched in the library by using the tool: https://kopkatalogs.lv/F/?func=find-b-0&local_base=rtu01

For the provision of the study programme, there are minimum of 108 books in Latvian and minimum of 626 books in English available in the RTU library. The complete list of books can be found by using the above search tool of the standard catalogue. Every year the range of books is supplemented by adding recent sources based on the survey of the academic staff providing study courses and by ordering relevant books.

In compliance with the search tool's data, ExLibris SFX allows the selection of resources in all the RTU electronic databases. A minimum of 283 industry magazines and 1278 electronic books are available for providing the study programme.

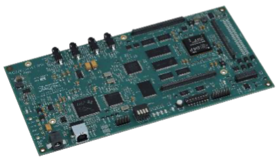
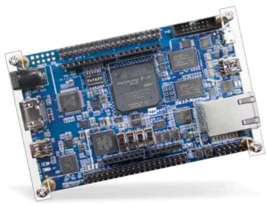
For the performance of laboratory assignments and practical assignments, ETF has access to specialised study laboratories with the modern equipment and software needed for mastering relevant practical skills within study courses. In addition to the basic study laboratories, students can also use the specialised laboratories located on the ETF premises:

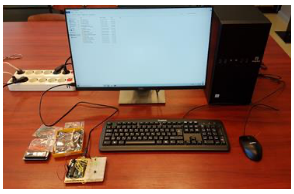
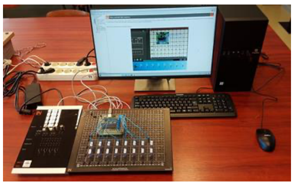
- Wireless sensor network and software-defined radio laboratory;
- Laboratory of Electroacoustics;
- Prototyping laboratory;

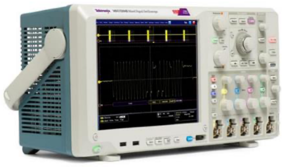
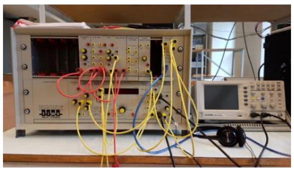
- Siemens IoT laboratory;
- Electronic devices testing centre of Latvia (LEITC);
- Electronics club.

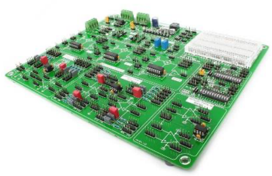
During the period from 2013 to 2022, for the implementation of the professional Bachelor study programme “Smart electronic systems” of the study field “Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management and Computer Science”, as well as the performance of scientific and applied research minimum 67 computers and 6 projectors were procured. Many computers were procured with SSD disks, increased RAM and 8-16 cores to ensure implementation of the study courses related to simulation of electromagnetic fields, programming and simulation of embedded systems.

The table presents examples of the equipment procured during the above period divided in compliance with the selected specialisation modules of the study programme courses:

Figure	Description	Use
Smart embedded systems		
	TMDSDSK6416-T DSP STARTER KIT (8 pcs.). Signal processor modules are used in the study courses of digital signal processing (“Digital Signal Processing” and Digital Signal Processing (study project)”) along with other relevant development tools.	Studies Research
	Electronics and robotics prototyping robot “SumoBoy” with a set of prototyping parts (4 pcs.). Robot sets are offered to the students of the 1st year for independent research and development of course papers in the study course “Electronic Control System Design”.	Studies
	Terasic Technologies DE10-Nano Development Kit (10 pcs.). FPGA development sets are used for learning HDL programming language in the study courses: " Fundamentals of Digital Electronic Systems Design using HDL " and " Fundamentals of Digital Electronic Systems Design using HDL (study project)". The sets are also used for the development of graduation papers.	Studies
	Terasic Technologies DE10-Standard Development Kit (10 pcs.). FPGA development sets are used for learning HDL programming language in the study courses: " Fundamentals of Digital Electronic Systems Design using HDL" and "Fundamentals of Digital Electronic Systems Design using HDL (study project)". The sets are also used for the development of graduation papers.	Studies

	The PSoCTM 6 WiFi-BT Pioneer Kit (CY8CKIT- 062-WiFi-BT)(10 pcs.). The sets are offered to students for learning additional materials in the study course “Embedded Systems Architecture and Peripherals”. They allow to get acquainted with the PSoC specific architecture and develop sensor network solutions on a Bluetooth basis.	Studies Research
	Silicon Labs Giant Gecko kit (20 pcs.). The development sets are used in practical classes in the study course “Embedded Systems Architecture and Peripherals”.	Studies
	Arduino Starter Kit sets are used and provided to students in the “Electronic Control System Design" study course.	Studies
	Lucas-Nulle UniTrain Interface and PIC16F887 microcontroller study sets. These are offered to students as additional development tools in the study course “Electronic Control System Design".	Studies
	Siemens Simatic IOT 2000 (6 pcs.). It is offered as additional equipment to students for learning to work with industrial programmable IoT devices (in Siemens IoT laboratory).	Studies
Signal processing and wireless communication systems		
	Adalm Pluto software-defined radio development sets (15 pcs.). The modules are intended for use in the study courses “Fundamentals of Smart Radio” and “Fundamentals of Smart Radio (study project), where they in combination with specialised MATLAB/ Simulink development tools, allow students to get practically acquainted with the basics of the smart programmable radio systems.	Studies

	USB connected multifunctional device (digital oscilloscope, signal generator, digital signal analyser) Analog Discovery 2 (AD2- 24 pcs.). The equipment is used to implement the practical part of several study courses thanks to the very extensive range of functions. For example, in study courses “Electron devices” and “Active electronic systems” AD2 is used to research the parameters and dynamics of discrete semiconductors and amplifier connections. In the study course “Signal Theory” AD2 is used for practical research of signal characteristics in the laboratory.	Studies
	Oscilloscope 2GHz 4+16 channels: MSO5204B with options MSO5204B 5RL and MSO5204B R3. A broad application oscilloscope is located in the “Wireless sensor network and software-defined radio” laboratory. It is available to students for developing graduation papers and scientific- research work.	Studies Research
	Study bench EMONA TIMS-301C PC enabled + changeable modules (30 pcs.). The equipment is used in study courses “Electrical Measurements in Telecommunications” and “Transmission systems”.	Studies
	Study bench EMONA 101 biskit (2 pcs.). The equipment is used in study courses “Electrical Measurements in Telecommunications” and “Transmission systems”.	Studies
Analogous and RF appliances and systems		
	RF signal generator SMC100A with B103 frequency option is used for demonstrations in the study course “Electrodynamics and RF devices", as well as development of graduation papers and implementation of the scientific work.	Studies Research
	The broadband 3D antennae IsoLOG 3D Mobile 9060 is used for demonstrations in the study courses "Antenna Design", "Electrodynamics and RF devices", as well as the development of graduation papers and implementation of the scientific work, allowing to obtain real-time data of radio signals at the angle of 360 degrees.	Studies Research

	Part of the microwave laboratory equipment is the close field probe HZ-14, NEAR-FIELD PROBE SET, 9kHz to 1GHZ. Allows measuring the electromagnetic radiation in a close area. It is used for demonstrations in the study course “Electromagnetic Compatibility: Components and Applications".	Studies Research
	A part of the set of antennae: biconical antenna (prototype-R_S HK116) 2 pcs., Manufactured by Rohde and Schwarz. It is planned to use it for demonstrations and experiments in the study courses: “Antenna Design”, “Antenna Design (study project)”,	Studies Research
	A part of the set of antennae: loop (magnetic) antenna (prototype R and S HFH2-Z2)-1 pcs. It is planned to use it for demonstrations and experiments in the study courses: “Antenna Design”, “Antenna Design (study project)”,	Studies Research
	A part of the set of antennae: logoperiodic antenna (prototype R and S HL223)-1 pcs., manufactured by Rohde and Schwarz. It is planned to use it for demonstrations and	Studies Research
	Vector network analyser MS2024B. The portable device is intended for working in the "Wireless sensor network and software- defined radio” laboratory, for the development of graduation papers and also in the study courses “Electrodynamics and RF Devices”, and “Fundamentals of Smart Radio ".	Studies Research
	Analog System LabKitPro (10 pcs.). The set provides extensive possibilities for research of the analog electronics components: comparators, operation amplifiers, multiplicators, supply sources, CAP and ACP, etc. It is used in the study course “Analog electronics".	Studies
Electronic hardware design		
	Source measuring device Keysight B2901A. The device allows for measuring energy consumption of low capacity consumers within short time intervals with high accuracy. It is applied for energy consumption measurements of embedded systems and wireless sensor network units research.	Studies Research

	Four-channel digital osciloscope RTA4000 with 200MHz band SN102743. It is offered to students for developing graduation papers, and research work. It allows uniform presenting and processing of up to 4 signals.	Studies Research
	Function generator HMF2550, SN102658 (HMF2550 50MHz Arbitrary Function Generator). It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics" and the development of graduation papers.	Studies Research
	Four outlet supply source HMP4040, SN108857(HMP4040 four-channel power supply). It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics" and the development of graduation papers.	Studies Research
	Digital multimeter HMC8012, SN106115 (HMC8012 R&S 5 3⁄4 Digit Multimeter). It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics", as well as for development of graduation papers.	Studies Research
	LCR measuring bridge HMC8118, SN105896 (HMC8118 LCR bridge). It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics", as well as for development of graduation papers.	Studies Research
	Hydrophone Teledyne TV4032 with auxiliary modules. It is used in scientific research work for underwater acoustic measurements. For demonstrations in the study course “Electroacoustics."	Studies Research
	Rotating table 8MR190-90-4247 with control for performing audio measurements. It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics", as well as for development of graduation papers.	Studies Research
	Measuring device CLIO FW STANDARD. It is used in the Electroacoustics laboratory and for demonstrations in the study course “Electroacoustics", as well as for development of graduation papers.	Studies Research

	Osciloscope PeakTech 1300. It is offered to students for developing graduation papers, and research work. It allows uniform presenting and processing of up to 4 signals.	Studies Research
	Omicron Lab Bode 100 Vector network analyser. It is used for the survey of various components (filters, coils, condensers, etc.) on an extensive frequency range. It is used to measure reverse link transmission characteristic curves for supply sources, amplifiers, etc. It is used to develop graduation papers in the study course “Active electronic systems".	Studies Research
	Impedance/ circuit analyser adapter for measurement of surface installation (SMD) passive electronic components. It can be used with Bode 100 equipment to measure SMD component parameters on an extensive frequency range. It is used to develop graduation papers in the study course “Active electronic systems".	Studies Research
	Impedance/ circuit analyser adapter for measurement of passive electronic components (with wire outlets) It can be used with Bode 100 equipment to measure outlet component parameters on an extensive frequency range. It is used for the development of graduation papers in the study course “Active electronic systems".	Studies Research
	Impedance analyser Keysight E4990A-120 with options 16047E and 16034H. The device is intended for survey of the parameters of electronic components over an extensive frequency range. It is used for scientific research work, development of graduation papers, and the study course “Electromagnetic Compatibility: Components and Applications".	Studies Research
	Soldering equipment ERSA PL IR550, manufactured by ERSA, allows high accuracy SMD component placement and soldering. It is accessible for students at study programmes of all levels to compose prototypes and soldering. It is also actively used in scientific research work to develop the first device prototypes.	Studies Research

	PCB milling machine LPKF Protomat S103 (1 pcs.), manufactured by LPKF laser. The equipment provides extensive possibilities to implement high precision pressed plates (up to 2 layers, also RF) in the prototyping laboratory. It is used for the development of graduation papers, in the study course “Design of Printed Circuit Boards ". It is used to implement and survey the first prototypes in the scientific research work.	Studies Research
	A1 colour plotter HP Designjet T520 91,4cm 36inch ePrinter CQ893A. It is used for printing teaching aids and printing posters for scientific conferences.	Studies Research
	Capacity analyser HA1600A Schuko TTI. It allows performing analysis of alternate voltage distortions. It is used to develop graduation papers and research work related to the development and improvement of AC supply sources.	Studies Research
	Alternate voltage source AC1000A Schuko TTI. It allows performing research of supply sources of various types by providing distortion-free and noise- free inlet voltage usually supplied from an industrial network and neighbouring consumers. It is used in the development of graduation papers and research work.	Studies Research
	Digital oscilloscope DS2202 RIGOL. It is offered to students for developing graduation papers and research work. It allows uniform presenting and processing of up to 2 signals.	Studies Research

Some equipment is shared and used both in the professional Bachelor study program "Smart electronic systems", professional Master study program "Smart electronic systems" and in the PhD program "Electronics".

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

Not applicable.

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU funding from the state budget consists of the funding based on the list of study programs and the number of students. It comprises funds for payment of utilities, taxes, maintenance of the infrastructure, procurement of inventory and equipment and staff wages, and funding for scientific activities.

The number of state budget funded seats is granted following negotiations with the Ministry of Education and Science. The study base funding from the state budget funds is allocated to full-time studies. The amount of the study base funding is defined based on the number of state budget funded seats at RTU defined by the state, the base costs of a study place defined by the state, and the rates of study costs of the thematic blocks of education. The rates of study costs of the thematic blocks of education are the indices defining the amount of costs of a study seat in the relevant thematic block of education in relation to the base costs of a study seat.

RTU has a decentralised budget. Therefore, each structural unit has a separate budget. In the general sense, the budget is a plan of revenues and expenditure for a particular period, assignment, event or function. In RTU, revenue and expense are managed according to the principles approved by the Senate or defined by the Vice-Rector for Finance according to his delegated authority.

Funding is allocated to structural units either in compliance with the fiscal or budget year or immediately following receipt of the funding. At RTU every head of a structural unit has remote access to actual financial information on a budget of the structural unit, including the scheduled workload and allocated funding in future periods for implementation of study programs and study courses. Based on this information, at the beginning of every fiscal or budget year, the head of a structural unit plans the activities of the structural unit, including wages for the teaching staff subordinated to the relevant structural unit head, and develops a procurement plan for the next year for providing implementation of the study program or courses.

The state budget funded seats in the professional Master study program "Smart electronic systems" are continuously filled, attesting to the quality and financial self-sufficiency of the study program. The primary sources of funds for the provision of the program per year are presented in detail in the table below:

Study year	Grant for the programme, EUR	Tuition fee in the programme, EUR		Total funding for the programme, EUR	Funding for one study place with state funding, EUR
		Tuition fees of local students, EUR	Tuition fees of foreign students, EUR		
2013/2014	269,145.0	23,248.00	-	292,393.00	3,866.00
2014/2015	220,555.15	17,368.67	-	237,923.82	3,866.02
2015/2016	186,714.76	34,428.25	-	221,143.01	3,866.02
2016/2017	179,942.42	45,127.94	13,796.26	238,866.62	3,866.02
2017/2018	195,275.61	40,521.73	29,705.44	265,502.78	4,040.66
2018/2019	203,458.76	35,935.00	52,131.84	291,525.60	4,229.68
2019/2020	222,944.30	39,025.00	63,044.39	325,013.69	4,405.04
2020/2021	225,277.04	37,108.00	72,763.44	335,148.48	4,462.81

Note: The professional Bachelor study programme “Smart electronic systems” was developed based on the academic Bachelor study programme “Electronics” which was later renamed “Electronics and mobile communications". The first students were enrolled in the programme in 2021. Therefore the data of preceding periods refer to the programme “Electronics” (“Electronics and mobile communications”).

The data analysis reveals that the funding consisted mainly of the state grant at the beginning of the reporting period. A small portion of funding was provided by students paying tuition fees. The funding gradually decreased as the interest in the programme decreased. Around 2016, the study programme was revised, and its title was changed accordingly. Enrolment of international students in the study programme was started in the same year. The above changes and diversification of income allowed increasing the total funding on all items, which positively affected the total programme funding. In response to the industry requirements, the programme content was repeatedly revised, and the new professional Bachelor study programme “Smart electronic systems” was developed on its basis. The first students were enrolled in 2021.

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "Funding distribution between the cost items"

Information on the minimum needed number of students in the program is presented in the annex to the self-assessment report "On minimal number of students in study programs".

Funding obtained in the program is used to cover daily expenses related to the implementation of the study program (for example, premises, utility payments, etc.). After making the mandatory payments, the remaining funding is used for the development of the study program: literature relevant to the content of the study program is purchased (for Latvian and international students), the existing stock of electronic components is maintained and replenished, new modern development kits for practical lessons are purchased (e.g., microcontroller programming, data transmission systems etc.).

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members (academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

RTU scientific and academic staff holding the PhD degree is involved in implementing the study programme, particularly 25 PhD holders who are each an expert in the relevant field. FET scientists and young scientists involved in the implementation of professional study courses have specialised in electronics. Substantiation of selection of the academic staff is related to the experience of scientists, the scientific research interests, scientific performance, etc., taking into account the specifics of the study programme and study courses. In compliance with the objectives of the study programme, the criteria for selection of the academic staff include knowledge of the recent achievement and participation in scientific and research projects in their relevant fields, teaching skills compliant with modern trends in the relevant field and experience of presenting study courses to international students in English.

In case of necessity, assistant professors from foreign partner universities may be involved in providing the study programme to deliver more practically focused lectures.

The academic staff of the professional field-specific study courses have professional experience in working in or managing electronics manufacturing companies.

Academic staff from other faculties also participates in implementing the programme by providing general education study courses, humanities and social study courses and language study courses. The summary of the staff involved in the study programme implementation provides data on the distribution, number, mean age, and holding of the PhD degree of the academic staff.

Academic staff involved in the implementation of the study programme in 2022

Position	**Total number of academic staff**	**Holding the Ph.D degree**	**Mean age**	**Number of EFT academic staff**	**Holding the PhD degree**	**Mean age**
Professor	7	7	66	1	1	40
Assoc. Professor	9	9	48	4	4	39

Assistant professor	11	9	59	8	7	60
Lecturers	11		43	9	1	41
Assistant	6		29	5		28
Total	44	25	49	27	13	43

Seven elected professors participate in implementing the programme - PhD degree holders whose scientific and teaching qualification complies with the criteria defined by laws and regulations on assessing applicants' scientific and teaching qualification for positions.

Nine elected associated professors participate in implementing the programme - PhD degree holders whose scientific and teaching qualification complies with the criteria defined by laws and regulations on assessing the scientific and teaching qualification of applicants for positions.

Also, assistant professors, lecturers, leading researchers, researchers and guest lecturers participate in implementing the study programme.

The qualification of the academic staff conforms with the provisions of Section 39 of the Law on Universities regarding the academic staff of professional study programmes. Assistant professors, lecturers and assistants participate in the provision of the study courses of the professional study programme, of whom 25 hold a scientific degree, 19 don't have a scientific degree but possess sufficient practical work experience compliance with the relevant study course. Lecturers and assistants who do not have scientific and academic degrees have practical work experience in electronics manufacturing companies amounting to five and even more years.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

During the reporting period, the study programme was substantially improved and developed, resulting in the development of the professional Bachelor study programme to replace the academic Bachelor study programme. More academic staff members were involved in implementing the professional Bachelor study programme, thus providing a higher volume of the study programme from the point of view of credit points.

In 2013 the academic Bachelor study programme was provided by 34 academic staff members, including 10 professors and 7 assoc. professors, 12 assistant professors/ acting assistance professors, 4 lecturers and 1 assistant, of whom 25 persons held the PhD degree. The mean age of the academic staff is 64 years. The professional Bachelor study programme is provided by 44 academic staff members, including 7 professors, 9 assoc. professors, 11 assistant professors and 6 assistants, of whom 25 hold a PhD degree, and 2 are PhD applicants who will defend their PhD Thesis in 2022. The mean age of the academic staff is 44 years. The change of generations and upgrade of the academic staff have occurred during the reporting period. New, gradually trained academic staff was involved in implementing the programme. The number of assistants and lecturers increased substantially, allowing for more efficient organisation of the study process and higher results.

As the academic Bachelor study programme was modified and replaced by the professional Bachelor study programme, new academic staff with experience in the industry and the scientific research work was involved. Experience in the industry improves the quality of provision and content of the professional improvement study courses. The experience in the scientific research work improves the professional level and competence of the academic staff by ensuring the application of the scientific approach in the solution of complicated tasks and educating students. The personnel involved in the provision of the study programme actively participates in implementing research projects as supervisors, leading researchers or researchers. Approximately 70% of the personnel are elected to scientific positions. It should also be noted that the number of research projects at the Institute of Radioelectronics and the involvement of research staff in them has increased considerably during the last three years.

Comparison of the academic staff involved in the implementation of the study programme in 2013 and 2022

Position	Total number of academic staff		Holding the PhD degree		Mean age		Number of FET academic staff		Holding the PhD degree		Mean age	
	2013	**2022**	**2013**	**2022**	**2013**	**2022**	**2013**	**2022**	**2013**	**2022**	**2013**	**2022**
Professor	10	7	10	7	72	66	4	1	4	1	64	40
Assoc. professor	7	9	7	9	69	48	3	4	3	4	70	39
Assistant professor	12	11	8	9	65	59	7	8	5	7	61	60
Lecturer	4	11			47	43	2	9	1	1	42	41
Assistant	1	6			7	29	1	5	1		28	28
Total	**34**	**44**	**25**	**25**	**64**	**49**	**17**	**27**	**14**	**13**	**59**	**43**

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

Not applicable.

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

Not applicable.

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

In the result of active cooperation of the teaching staff, the provision and improvement of the programme is implemented continuously and effectively. Considering the fact that students were enrolled in the professional Bachelor study programme in 2021, at present 36 students study in the first year and 40 academic staff members are involved in the study process for providing four years of studies.

Professional study courses, teaching materials, the study program, development strategy and the sustainability plan are continuously updated, supplemented and improved. Also, new study courses are either created or added considering the sequence of study courses. Improvements are based on the scientific activity of the teaching staff, analysis of the current trends, incorporation of changes from the RTU strategy, and following the industry development trends. The study process is also being adopted at various levels of change: global, national, university, and faculty. Amendments of the national laws related to the organisation of the study process, the RTU internal orders for providing the study process, changes in the development strategy of RTU and the faculty, the industry development trends on the national, European and global levels are followed. The students' opinions regarding the quality of the materials of study courses and teaching, regular surveys and meetings with the faculty management are also considered. Also, references by the industry, in the students' internship assessments and requirements to the industry experts presented at the meetings of the Latvian Electrical Engineering and Electronics Industry Association (LETERA), job advertisements and the profession standard are taken into account.

Various communication channels are envisaged and used for ensuring cooperation:

- In-person and remote meetings on the level of the Institute of Radioelectronics - improvement of the development strategy and the sustainability plan, updating of the study program, discussions and adjustments of the study plans, analysis of students' progress, improvement and sequence of study courses, development of new courses, discussion of the themes of qualification papers, an adaptation of the study process to various changes.
- In-person and remote meetings on the level of departments - for the planning of the academic year/ half a year, discussion of changes of the study process in the circumstances of COVID pandemic, approval of the topics of qualification papers, coordination of the teaching of study courses, approval of individual internship programs.

- In-person and remote meetings on the level of individual sub-fields - for improvement of study courses and continuity, development of new courses, motivation of students, involvement of students in scientific or study process.
- Meetings of heads of departments - for discussion of strategic and essential issues and agreement thereof.
- E-mail - for disseminating orders related to the study process, announcing various events, and sharing other current information.

- Seminars and open lectures devoted to the teaching work on the level of the Institute of Radioelectronics and the faculty.
- Social networks, like Facebook, Instagram - for the announcement of various events.
- Messengers, for example, WhatsApp groups on the level of the institute and the faculty - for discussing important and urgent issues and sharing information.
- Cloud storage, like Onedrive, GoogleDocs, Microsoft Teams - for the development of joint documents and materials, storage and shared access.
- ORTUS - the uniform RTU system for sharing and storing of descriptions and materials of study courses, provision of the study process, distribution of results of scientific activity, storing and sharing of graduation projects, the announcement of news and events, surveys of students regarding the quality of provision of study courses - used for the provision of the study processes on a daily basis.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	P28_3.1.2_ECV0(42523)_DiplPielik_LV_DiplSupplemt_ENG.zip	P28_3.1.2_ECV0(42523)_DiplPielik_LV_DiplSupplemt_ENG.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)		
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_ECV0(42523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_ECV0(42523)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard	P06_3.2.1_ECV0(42523)_Compliance with the state education standard_ProfBak_EN.pdf	P06_3.2.1_ECV0(42523)_AtbilstibaValstsStandartam_ProfBak_LV.pdf
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)	P07_3.2.1_ECV0(42523)_AtbilstībaProfStand_ProfBak_EN.pdf	P07_3.2.1_ECV0(42523)_AtbilstibaProfStand_ProfBak_LV.pdf
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_ECV0(42523)_Kartejums_lv_Mapping_eng.pdf	P08_3.2.1_ECV0(42523)_Kartejums_lv_Mapping_eng.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_ECV0(42523)_Plans_lv_Plan_eng.zip	P09_3.2.1_ECV0(42523)_Plans_lv_Plan_eng.zip
Descriptions of the study courses/ modules	Bak_studiju kursi_ENG.zip	Bak_studiju kursi_LV.zip
Description of the organisation of the internship of the students (if applicable)	P31_ECV0(42523)_PraksesOrganiz_LV_InternshipManagem_ENG.zip	P31_ECV0(42523)_PraksesOrganiz_LV_InternshipManagem_ENG.zip
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)		
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)		

Computer Science and Information Technology (51482)

Study field	*Information Technology, Computer Hardware, Electronics, Telecommunications, Computer Management, and Computer Science*
ProcedureStudyProgram.Name	*Computer Science and Information Technology*
Education classification code	*51482*
Type of the study programme	*Doctoral study programme*
Name of the study programme director	*Jānis*
Surname of the study programme director	*Grabis*
E-mail of the study programme director	*janis.grabis_1@rtu.lv*
Title of the study programme director	*Dr. sc.ing.*
Phone of the study programme director	*67089594*
Goal of the study programme	*The objective of the study programme is to prepare highly qualified specialists and researchers in the area of: 1) Electrical engineering, Electronic engineering, Information engineering with specialization in systems analysis, modelling and design; or 2) Mathematics with specialization in applied mathematics and mathematical modelling or probability and mathematical statistics, who are able to carry out state of the art research and solve complex real-life problems.*
Tasks of the study programme	*• To prepare students for independent research work in academia and industry; • To promote knowledge transfer to industry; • To develop the individual abilities of students and to provide a stimulating environment; • To strengthen abilities of continuous self-development of knowledge and professional skills; • To develop critical, analytical and systematical thinking and to develop collaborative skills; • To explain and advocate the role of computer science and information technology in society.*

Results of the study programme	*• Ability to identify the significant and promising direction of the doctoral research and to formulate research challenges; • Ability to select and to used scientific research methods; • Ability to independently plan and carry out scientific research and to perform critical analysis, synthesis and evaluation; • Ability to present and to defend results of the scientific research; • Ability to publish research results in scientific publications; • Ability to implement technology transfer and projects and to promote scientific achievements to the general public; • Ability to solve complex computer science and information technology problems in a systematic and formal manner; • Ability to perform scientific and practical experiments, process data and disseminate results on open research repositories; • Ability to follow and to promote principles of ethical research; • Research specific outcomes: - Ability to create new methods and algorithms for systems modelling, design, implementation and optimization; - Ability to create new methods and technologies in computer engineering including computer architecture, computer networks and computer control; - Ability to create new methods and technologies in applied mathematics and statistics.*
Final examination upon the completion of the study programme	*Defence of the Doctoral Thesis at the Promotion Council.*

Study programme forms

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*1. Master degree of engineering science in electrical engineering, electronics, information and communication technologies or Master degree of natural sciences in computer science and informatics, mathematics, or comparable education. 2. Master degree of engineering science or Master degree of natural sciences, or Master degree of social sciences, or comparable education, fulfilling the preconditions*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*

Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - latvian

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*latvian*
Amount (CP)	*192*
Admission requirements (in English)	*1. Master degree of engineering science in electrical engineering, electronics, information and communication technologies or Master degree of natural sciences in computer science and informatics, mathematics, or comparable education. 2. Master degree of engineering science or Master degree of natural sciences, or Master degree of social sciences, or comparable education, fulfilling the preconditions.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Mathematics*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*
Admission requirements (in English)	*1. Master degree of engineering science in electrical engineering, electronics, information and communication technologies or Master degree of natural sciences in computer science and informatics, mathematics, or comparable education. 2. Master degree of engineering science or Master degree of natural sciences, or Master degree of social sciences, or comparable education, fullfilling the preconditions. 3. English language proficiency equivalent to at least CEFR B2 level.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Electrical Engineering, Electronics, Information and Communication Technologies*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

Full time studies - 4 years - english

Study type and form	*Full time studies*
Duration in full years	*4*
Duration in month	*0*
Language	*english*
Amount (CP)	*192*
Admission requirements (in English)	*1. Master degree of engineering science in electrical engineering, electronics, information and communication technology or Master degree of natural sciences in computer science and informatics, mathematics, or comparable education. 2. Master degree of engineering science or Master degree of natural sciences, or Master degree of social sciences, or comparable education, fulfilling the preconditions. 3. English language proficiency equivalent to at least CEFR B2 level.*
Degree to be acquired or professional qualification, or degree to be acquired and professional qualification (in english)	*Doctor of Science (Ph.D.) in Mathematics*
Qualification to be obtained (in english)	–

Places of implementation

Place name	City	Address
Riga Technical University	RĪGA	KAĻĶU IELA 1, CENTRA RAJONS, RĪGA, LV-1050

3.1. Indicators Describing the Study Programme

3.1.1. Description and analysis of changes in the parameters of the study programme made since the issuance of the previous accreditation form of the study field or issuance of the study programme license, if the study programme is not included on the accreditation form of the study field, including changes planned within the evaluation procedure of the study field evaluation procedure.

The study program "Computer Science and Information Technology" was licensed on 14 July, 2021. It combines three previously implemented study programs of the Faculty of Computer Science and Information Technology – "Computer Systems", "Information Technology" and "Automation and Computer Management", in which students are no longer enrolled.

No changes have been made to the parameters of the study program since licensing.

3.1.2. Analysis and assessment of the study programme compliance with the study field. Analysis of the interrelation between the code of the study programme, the degree, professional qualification/professional qualification requirements or the degree and professional qualification to be acquired, the aims, objectives, learning outcomes, and the admission requirements. Description of the duration and scope of the implementation of the study programme (including different options of the study programme implementation) and evaluation of its usefulness.

The study program prepares a wide range of high-skilled IT specialists with integrated education and systemic thinking, independent scientific and pedagogical work skills, knowledge and skills for business and higher education institutions. They are employed in scientific research institutes, IT companies, local governments, ministries, as well as to act as evaluators of scientific achievements, experts of international organizations, etc.

The previous education requirements are: 1) Master's degree in electrical engineering, electronics, information and communication technologies or Master's degree in natural sciences in computer science and informatics, or Master's degree in natural sciences in mathematics, or compatible education; 2) Master's degree in engineering sciences or Master's degree in natural sciences, or Master's degree in social sciences, or compatible education, fulfilling the preconditions.

The preconditions mentioned in Point 2 are:

- Candidates should have at least 30 CP worth of courses in the areas of computer science and information technology and mathematics including courses on mathematics, statistics, programming, data bases and computer networks.
- To qualify for the PhD in mathematics a candidate should have had courses in mathematical analysis, time series analysis and random processes.

To fulfil the preconditions an individual plan is prepared and study courses are taken prior to PhD studies or in parallel if a few courses are missing.

RTU offers the following courses to fulfil the preconditions:

Knowledge	**Study Course**	**CP**
Mathematics	DIM701 Mathematics	9
Statistics	DMS212 Probability Theory and Mathematical Statistics	2
Programming	DIP107 Algorithmization and Programming of Solutions DPI503 Evolution of Object-Oriented Software	6 4
Data bases	DSP201 Data base management system DSP451 Large data bases	4 4
Computer Networks	DOP319 Computer networks	3

To qualify for the PhD in mathematics the following courses are offered at RTU:

Knowledge	**Study Course**	**CP**
Mathematical analysis	DMS211 Differential equations	3
Time series analysis	DMS100 Tome series analysis	4
Random processes	DMS214 Random processes	2

Graduates of the study program obtain a PhD degree in electrical engineering, electronics, information and communication technologies or mathematics, which corresponds to the upper limit of knowledge and allows solving critical engineering problems in research and innovation, which allows starting independent professional, scientific or academic activities, expanding existing knowledge and providing a new understanding of the topics of the field of computer science and information technology. The result of the study program is an independently developed PhD Thesis of significant theoretical significance and potential for practical use, which includes results of original scientific research obtained by independently evaluating and selecting research methodologies and methods corresponding to modern research, and provides new scientific and professional knowledge in the field of computer science and information technology. The educational classification code of the study program is 51482, which combines natural sciences, mathematics and information technologies and corresponds to the objective of the study program to ensure the acquisition of a scientific degree in both fields. The duration of the study program is four years, which is appropriate for the development of the PhD Thesis and is in line with the world practice. The English language variant of the study program has the same study load and duration because the only difference is a mandatory requirement to have a course on foundations on Latvian language, which can be either had in previous studies or selected as a free elective.

The study program is implemented in the field “Information Technologies, Computer Technology, Electronics, Telecommunications, Computer Control and Computer Science”, because it covers the core topics of the filed Information Technologies, Computer Technology, Computer Control and Computer Science.

3.1.3. Economic and/ or social substantiation of the study programme, analysis of graduates' employment.

The study program corresponds to the current demand of the labor market, and its graduates will be competitive. Latvian ICT companies are gradually moving towards creation of high value-added products (see analytical review of the ICT research ecosystem in the specialization area of RIS3[1]), which requires specialists with a PhD (doctoral degree), which secures the demand for specialists. Potential PhD students are motivated by opportunities for creative work and higher salaries for specialists with PhD to choose PhD programs (CV-Online study shows that PhD degree holders receive on average 15% higher salary than Master's degree holders). RTU is active in attracting international students, and their share at the Bachelor's and Master's study programs reaches 15%, which opens up a wide range of opportunities to attract foreign students to PhD studies as well.

The development of the study program complies with the basic development documents of Latvia. Since the study program is also offered to international students, it will contribute to the internationalization of the higher education offered in Latvia, but the quality content of the study program that meets the requirements of the market will increase competitiveness of education by increasing the number of international students, which is in line with:

- "Education Development Guidelines 2021-2027" Objective 2 "Modern, high-quality and highly valued skills in the labor market, education offer";
- the need to increase the share of international students noted in the "Sustainable Development Strategy of Latvia until 2030".

It is very important to educate and train PhD holders in computer science and information technology specifically in Latvia, at the study program under consideration, for the following reasons:

1. The study program is special in that it provides fundamental knowledge in the field of computer science and information technology, using modernized teaching methods in the study process (situation analysis, research work, presentations in scientific seminars, etc.).
2. The above-mentioned set of the acquired knowledge and skills makes the study program unique and suitable for the conditions of Latvia.
3. Graduates of the study program have great employment opportunities in Latvia, working in local and international scientific-technical projects that require knowledge and skills in information technologies, robotics, synthesis of new materials, medical engineering, etc. Thanks to the fact that specialists of the appropriate level are being trained in Latvia, the IT sector has become one of the niches of the Latvian economy. Analyzing the outlook specifically in the IT field, it should be noted that the development of this industry does not require significant material resources, however, is demanding on human resources. Therefore, it is very important to acquire a study program in parallel conducting research in the conditions of Latvia.
4. The study program ensures that research in the field of computer science and information technology takes place in Latvia, thus helping Latvia to avoid falling into technological backwardness and becoming only a country – recipient of technology.

With the help of the study program, high-class specialists are educated and trained for the needs of the state, who are able to perform process and technology evaluation, analyze engineering problems, applying modern computer equipment and software, create new devices and technologies.

Graduates work in higer education institutions (~30%) and industry (~70%). According to the state survery from 2017 and 2018, 100% of the graduates is employed.

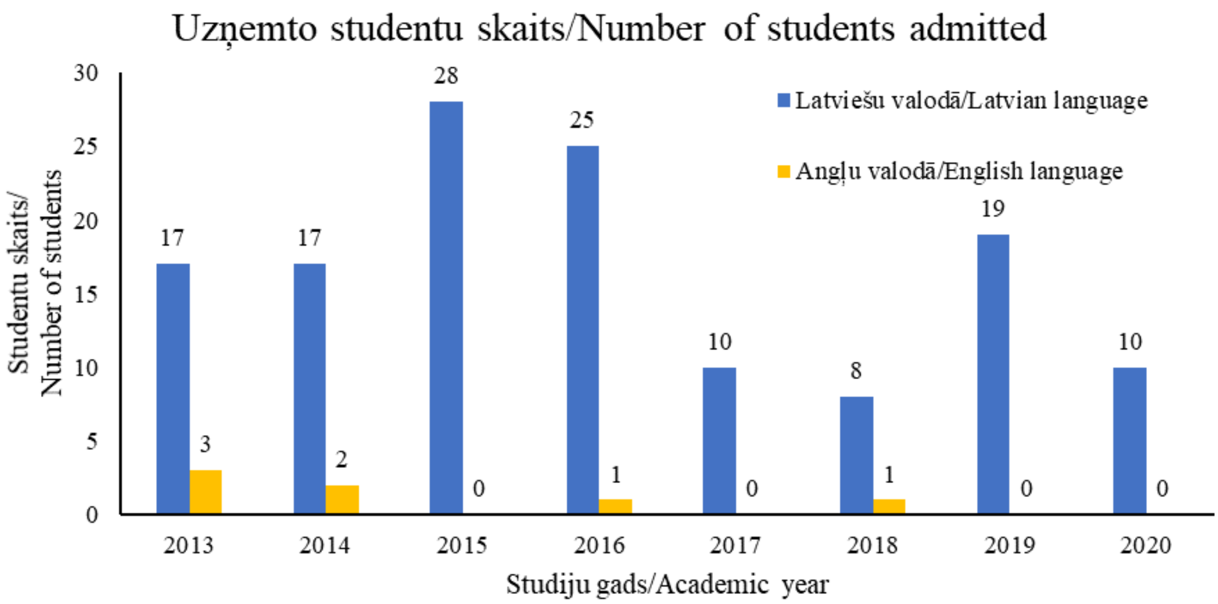
[1] https://www.izm.gov.lv/lv/ris3-monitorings (only in Latvian)

3.1.4. Statistical data on the students of the respective study programme, the dynamics of the number of the students, and the factors affecting the changes to the number of the students. The analysis shall be broken down into different study forms, types, and languages.

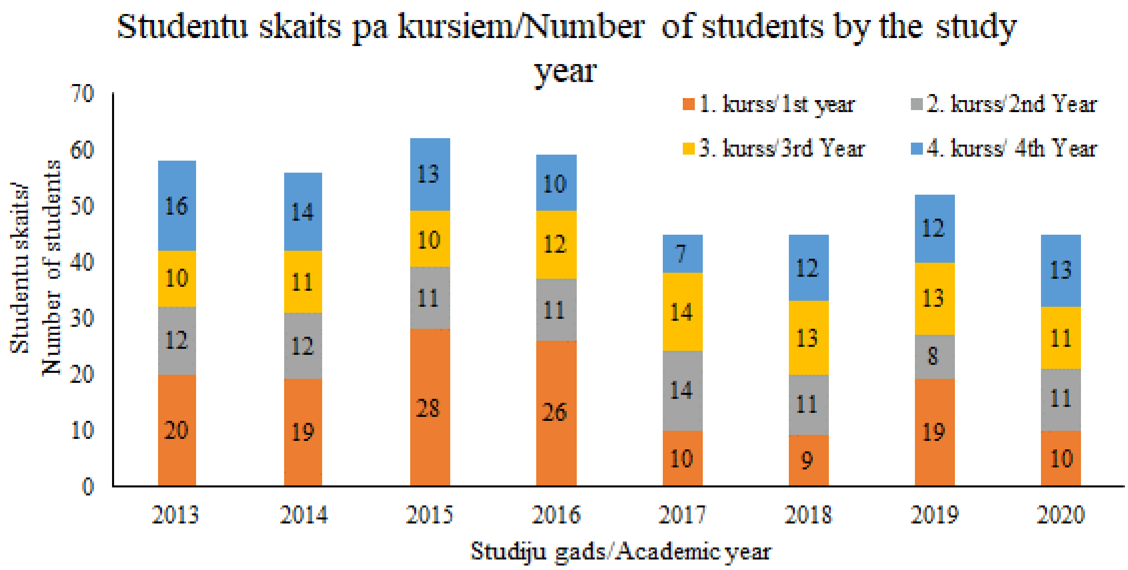
The first admission to the study program took place in the academic year 2021/2022. 8 Latvian and 1 international student were enrolled in the study program.

From the existing PhD study programs "Computer Systems", "Information Technology" and "Automation and Computer Management", 4 students were transferred to the 2nd course, for which appropriate individual plans were developed. The development of the study program envisages that in future (from 2024/2025), 20 Latvian students and 5 international students will be admitted.

Historical admission data are given below for students in Latvian and English. The number of students studying in English is small because not all previous doctoral study programs had English language delivery and the main target group was foreign students who obtained the Masters degree in Latvia. The admission requirements are made more flexible and more foreign students are expected.



Below are the total historical data on the number of students in the study programs "Computer Systems", "Information Technology" and "Automation and Computer Control".



3.1.5. Substantiation of the development of the joint study programme and description and evaluation of the choice of partner universities, including information on the development and implementation of the joint study programme (if applicable).

3.2. The Content of Studies and Implementation Thereof

3.2.1. Analysis of the content of the study programme. Assessment of the interrelation between the information included in the study courses/ modules, the intended learning outcomes, the set aims and other indicators with the aims of the study course/ module and the aims and intended outcomes of the study programme. Assessment of the relevance of the content of the study courses/ modules and compliance with the needs of the relevant industry, labour market and with the trends in science on how and whether the content of the study courses/ modules is updated in line with the development trends of the relevant industry, labour market, and science.

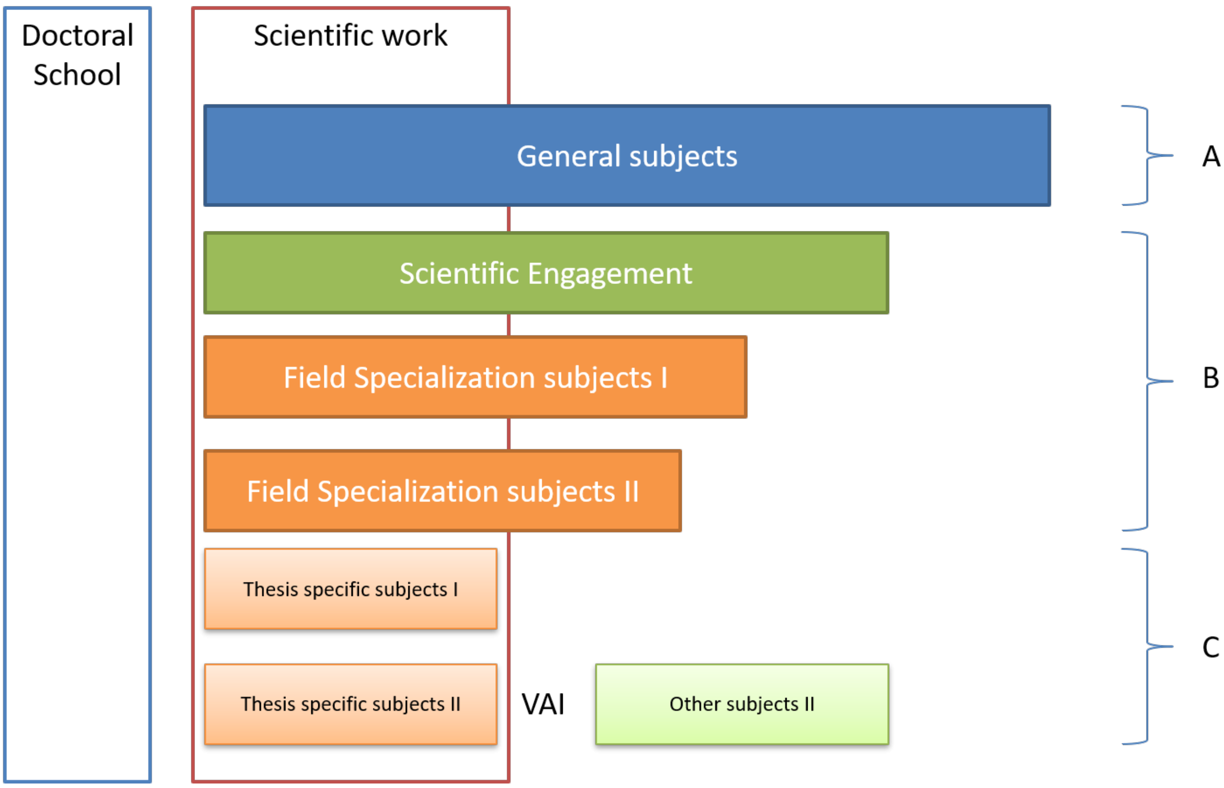
The study program is implemented in the form of lectures, practical and laboratory classes, as well as independent studies, acquiring the latest achievements in the field of computer science and information technology, using the achievements of fundamental and applied science, as well as acquiring in-depth theoretical knowledge in the chosen research field.

Within the framework of the study program, a wide range of high-skilled IT specialists with integrated education and systemic thinking, independent scientific and pedagogical work skills, knowledge, and skills necessary for work in economic institutions are educated and trained, which can be employed in scientific research institutes, IT companies, local governments, ministries, as well as to act as evaluators of scientific achievements, experts of international organisations, etc.

Previous education necessary for the acquisition of the study program: 1) Master's degree in electrical engineering, electronics, information and communication technologies or Master's degree in natural sciences in computer science and informatics, or Master's degree in natural sciences in mathematics, or compatible education; 2) Master's degree in engineering sciences or Master's degree in natural sciences, or Master's degree in social sciences, or compatible education, fulfilling the preconditions.

Graduates of the study program obtain a PhD degree in electrical engineering, electronics, information and communication technologies or mathematics, which corresponds to the upper limit of knowledge and allows solving critical engineering problems in research and innovation, which allows starting independent professional, scientific or academic activities, expanding existing knowledge and providing a new understanding of the topics of the field of computer science and information technology. The result of the study program is an independently developed PhD Thesis of significant theoretical significance and potential for practical use, which includes results of original scientific research obtained by independently evaluating and selecting research methodologies and methods corresponding to modern research, and provides new scientific and professional knowledge in the field of computer science and information technology.

Studies last a full four years, during which compulsory study courses, specialization and free elective study courses are offered. The compulsory study courses of the study program are common to all students of the study program, and they provide the knowledge necessary for the independent development of the PhD Thesis and practical use of the acquired results of the research. In the study course "Scientific Seminars", students acquire the knowledge necessary for the preparation and submission of scientific publications (a small description of mandatory study courses).



Compulsory elective study courses, which allow supplementing students' competences, include professional specialisation study courses. Study courses are in the fields of electrical engineering, electronics, information and communication technologies, as well as in the fields of applied mathematics and mathematical modelling or probability theory and mathematical statistics of the field of mathematics. Students choose study courses in the amount of 15 CP according to the topic of their PhD Thesis. Both compulsory and compulsory elective study courses are adapted to each student individually, considering the topic of research of the student, thus deepening the student's knowledge in the particular field of research. Students take study courses in the fields of information technology and applied mathematics in the amount of 10 CP. Students are advised to acquire one study course related to the theme of their PhD Thesis and one study course in another field of information technology or applied mathematics. One study course shall be selected in a group of research-related study courses. The task of this group of study courses is to provide students with a broader understanding of the philosophy and role of science in society, as well as to involve students in a wide range of scientific activities. Free elective study courses allow acquiring in depth the knowledge necessary for the development of the PhD Thesis or widely used knowledge, including study courses provided by other organizational units of RTU and foreign higher education institutions and study courses acquired outside formal education (e.g., "Coursera"). The study program also offers free elective study courses in the current fields of science, including cybersecurity, high performance computing and digital transformation. The choice of elective study courses depends on the student's research theme and skills to be acquired for successful development of the PhD Thesis. Foreign students also take the study course VSL711 Latvian.

The variety and interdisciplinary nature of the study courses offered by the study program allows students to develop the necessary competencies, thus facilitating the training of highly qualified specialists who meet the requirements of the modern labor market and knowledge-intensive economy; and also allows students to reach the advanced limit of knowledge in the chosen field of specialization. Taking into account the results of the mapping of the study courses, it can be argued that the curricula of the study courses is mutually aligned and ensure the achievement of the leaning outcomes of the study courses and the study program. The acquisition of the study program is completed by viva voce examination of the PhD Thesis in the Doctoral Council.

Renewal of the curricula of study courses is carried out in accordance with RTU regulations. If significant changes are made to the content, then they are reviewed by the Field Committee of the field "Information Technologies, Computer Engineering, Electronics, Telecommunications, Computer Control and Computer Science", which also includes representatives of the industry. Operational changes are made by drawing up the calendar plan for the current semester in accordance with RTU Regulations "On the Use of RTU E-learning System in Delivery of the Study Courses".

The presentation of scientific achievements is based on the activities of academic staff in international and national research projects, and the results of the projects are reflected in the study courses (the full list of scientific projects of the academic staff is available in their CVs). Research results are used in the study courses. The current areas of research are evaluated in the context of the global trends, evaluating the programmatic documents of Digital Europa and IEEE Computer Society: Technology Predictions. Cooperation with industry representatives is also carried out within the framework of the program implemented by the Information and Communication Technology Competence Center (ICTCC). At the seminars organized by ICTCC, applied research is discussed together with industry topicalities and feedback on the current events and needs of the industry is obtained.

The aim of the study program "To educate and tarin highly qualified specialists in computer science and information technology for independent scientific and pedagogical work in higher education institutions, scientific institutions and knowledge-intensive enterprises capable of carrying out high-level fundamental research and solving practical problems of high complexity", which corresponds to Level 8 of the European Qualifications Framework (EQF) and the Latvian Qualifications Framework (LQF) is reached in the process of program implementation.

In accordance with the Regulations of PhD Studies at RTU, PhD studies shall be carried out according to an individual plan, independent work of a PhD student is managed by the scientific supervisor in accordance with the requirements of the study program with the aim of obtaining a PhD degree. The study program complies with RTU Regulations on PhD Studies and the requirements set out therein.

The study courses of Parts A, B and E ensure that the graduates of the study program acquire the necessary competencies, they contribute to the achievement of the leaning outcomes of the study program.

3.2.2. In the case of master’s and doctoral study programmes, specify and provide the justification as to whether the degrees are awarded in view of the developments and findings in the field of science or artistic creation. In the case of a doctoral study programme, provide a description of the main research roadmaps and the impact of the study programme on research and other education levels (if applicable).

The PhD study program "Computer Science and Information Technology" (hereinafter – the study program) will be implemented at Riga Technical University (RTU) from the academic year 2021/2022. Alumni of the study program will receive a PhD in engineering or natural sciences.

The PhD study program is one of the cornerstones of the scientific development of the Faculty of Computer Science and Information Technology. In the international evaluation of scientific institutions performed in 2019, the FCSIT received a rating of "4" out of "5". The evaluation highlighted in particular the contribution to economic development. The high evaluation attests high scientific potential of the FCSIT and the academic staff of the study program.

The study program is being developed within the framework of 8.2.1.SAM project No. 8.2.1.0/18/A/013 "Reducing the Fragmentation of Study Programs of Riga Technical University and Strengthening Resource Sharing", and it combines three PhD study programs implemented so far at RTU Faculty of Computer Science and Information Technology (hereinafter – FCSIT). This will allow to significantly increase the academic potential of the study program and increase the quality of studies.

The study program is developed in accordance with RTU Strategy and RTU Research Program. The main objective of RTU Strategy and Development Program for 2021-2025is to ensure the priority "Knowledge and skills for personal and national growth" included in the National Development Plan for 2021-2027. RTU positions itself as one of the cornerstones of the development of Latvia, which ensures education and training of the specialists necessary for the Latvian economy, as well as the creation of new products and services, serving as the basis for sustainable growth of Latvia. RTU Strategy includes the most important settings for the development of RTU in the period up to 2025, as well as determines the division of activities to be performed and responsibility for the performance of the set tasks.

In order to implement RTU's vision to become the leading science and innovation university of the Baltic States by 2025, the Strategy defines three aims of the university – a high-quality study process, excellent research, as well as sustainable innovation and commercialization (valorization). The aim of a high-quality study process is internationally competitive, analytical and creative specialists educated in prestigious, internationally recognized high-quality studies, who ensure the development of the Latvian national economy and have the capacity for lifelong learning. The aim of excellent research is high-quality scientific research that meets the needs of the Latvian and international economy, the results of which are widely involved in international, national and sectoral research programs and integrated into the study process. The aim of sustainable valorization is an effective environment for the development of technology and innovation transfer, which promotes establishment of new technological enterprises and the creation of products.

The study program provides an opportunity to educate a PhD in Science who will be able to work in various Latvian and foreign companies, higher education institutions, research institutions and other organizations where research knowledge, skills and competences are required.

The study program is created in accordance with the horizontal priorities of RTU Strategy and Development Program:

- internationalization or internationally competitive university activities in the fields of science, innovation and studies;
- interdisciplinarity or cooperation between different sectors and specializations as the basis for the creation of new and innovative products and modern study curriculum.

RTU FCSIT has successfully internationalized Bachelor's and Master's study programs in the IT field. The internationalization of the PhD study program is an important step towards ensuring the implementation of study programs within all educational cycles. Interest in PhD studies at RTU among foreigners is growing rapidly. This includes both RTU Master students and graduates of other higher education institutions. FCSIT research is increasingly carried out in cooperation with companies, and structural change of existing study programs is necessary, as individual organizational units do not have sufficient capacity to implement large projects, as well as practical research aspects should be reflected in the study program. The merging of PhD study programs should be carried out in order to consolidate the resources necessary for the implementation of study programs and to make RTU a faster development center of engineering at the international level. As a result of consolidation, a significant increase in academic capacity is expected – from an average of six professors in separate study programs to 15 professors in the joint study program. The restructuring of the content of the study program is aimed at strengthening cooperation with the industry, which is necessary for the implementation of socially significant and large-scale knowledge-intensive projects.

The aim of the study program is to educate and tarin highly qualified specialists and research staff: 1) in the sub-sectors of computer control or system analysis, modelling and design of the field of electrical engineering, electronics, information and communication technologies; or (2) in the mathematical fields of applied mathematics and mathematical modelling or probability theory and mathematical statistics, capable of carrying out high-level fundamental research and solving practical problems of high complexity.

FCSIT, in accordance with guidelines developed in Latvia and provided by the European Commission, has defined the following main research fields in the research areas of Computer Science and Information Systems:

- Massive Computational Intelligence for Evolutionary Digital Enterprises (leading organizational unit: ITI (Institute of Information Technology);
- Ambient Intelligence for Smart and Autonomous Systems and their Integration (leading organizational unit: Institute of Applied Computer Systems);
- Pervasive data processing (communication, computing and management) in distributed complex environments (leading organizational unit: Institute of Information Technology);
- Mathematical modelling (leading organizational unit: Institute of Applied Mathematics.

Sub-fields of the research field Massive Computational Intelligence for Evolutionary Digital

Enterprises:

- Context aware and adaptive enterprise applications;
- Data analysis and model-integration solutions for information technology management including project, service and risk management;
- Data analysis and model integration solutions for information technology project management and information technology service and risk management;
- Simulation-Based Sustainable Management of Complex Systems;
- Simulation Metamodeling and Optimization;
- Decision support systems and computational intelligence.

Research field Ambient Intelligence for Smart and Autonomous Systems and their Integration includes sub-fields necessary for the development of software and hardware intelligent systems:

- Artificial intelligence inlcuding intelligent agents & multi-agent systems, machine learning, knowledge engineering, ontologies;
- Autonomous intelligent systems, autonomous robots;
- Tools and methods for object-oriented software engineering and software security;
- Model driven software engineering;
- E-learning, including intelligent tutoring systems;

Sub-fields of the research field Pervasive data processing in distributed complex environments:

- Image Processing and Scene Analysis Methods (in 2D and 3D space);
- Sensor Systems and Networks;
- Exploring Hierarchy Architecture for Wireless Network Management;
- Computer Systems in Medicine.

Principal research sub-field for the research field Mathematical Modelling:

- Fluid flow modelling and stability studies;
- Non-destructive quality control of products.

Particular examples of applied research results are studies in interactive public transport simulation and optimization field, Research in autonomous and mobile robotics, including the training simulator for the underwater robot control learning in demining operations for the NAF Naval Force Training Centre in Liepaja and industrial cleaning machines in cooperation with Columbus and Stolzenberg; and studies on sclable dig data processing from IoT devices in cooperation with Leading Latvian telecommunication company TET.

3.2.3. Assessment of the study programme including the study course/ module implementation methods by indicating what the methods are, and how they contribute to the achievement of the learning outcomes of the study courses and the aims of the study programme. In the case of a joint study programme, or in case the study programme is implemented in a foreign language or in the form of distance learning, describe in detail the methods used to deliver such a study programme. Provide an explanation of how the student-centred principles are taken into account in the implementation of the study process.

The study program implements student-centered learning. Student-centered education considers the diversity of students and the variety of ways of study implementation, uses different pedagogical methods, promotes mutual respect in the relationship between the student and the academic staff and provides students with opportunities to provide feedback.

The persons who have acquired the following education may be enrolled in the study program:

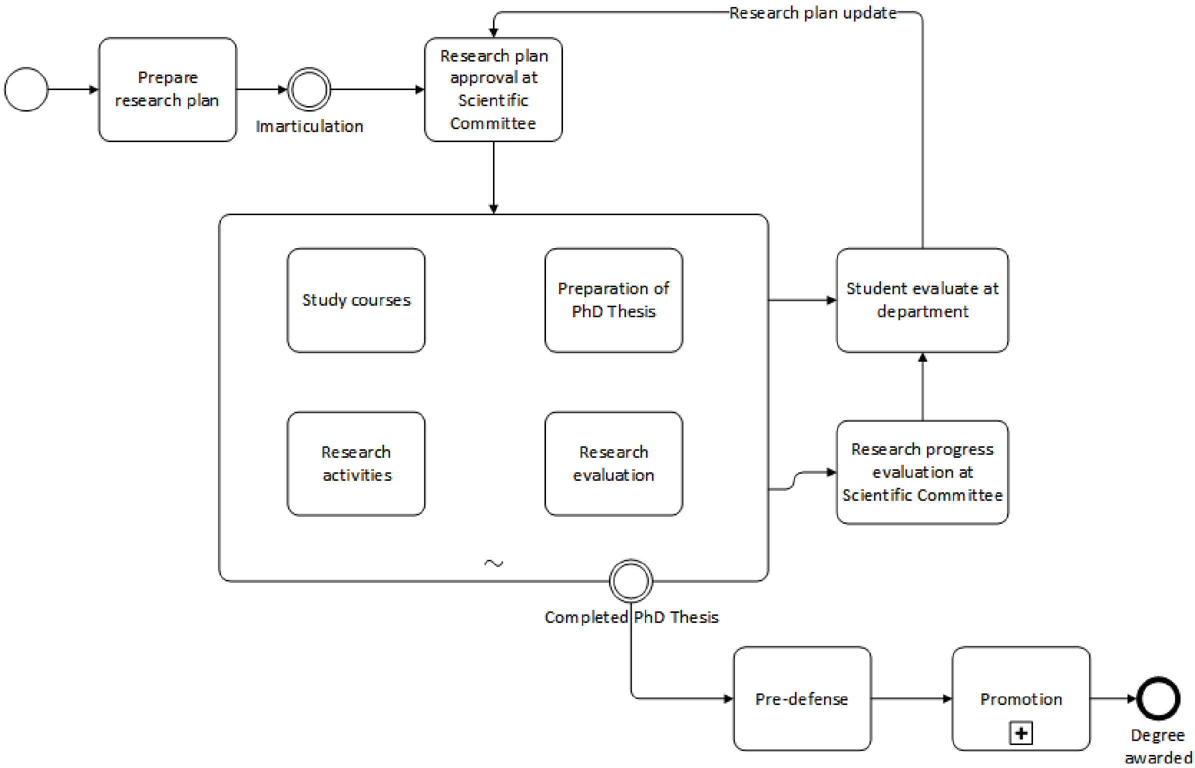
1. Master's degree in electrical engineering, electronics, information and communication technologies or Master's degree in computer science and informatics, or Master's degree in natural sciences in mathematics, or compatible education.
2. Master's degree in engineering sciences or a degree in natural sciences, or Master's degree in social sciences, or a compatible education, fulfilling the preconditions.

The prerequisites for admission for students of other fields include their previous education, including non-formal education, their learning outcomes in mathematics and statistics, programming, databases and computer networks. Applicants must have completed the study courses in computer science and information technology and mathematics in the amount of at least 30 CP during undergraduate and post-graduate studies (which corresponds to the number of credit points required for obtaining the second major in the world's universities). In order to qualify for a PhD degree in mathematics, the applicant must have completed additional chapters in differential calculations, systems of non-linear equations, time series analysis and case processes. The assessment of the fulfilment of preconditions shall be organized by the Head of the Study Program and the Scientific Committee of the FCSIT in accordance with RTU regulations regarding the “Procedures for recognition of study courses acquired in other higher education institutions and study programs” (only in Latvian) and “Procedures for recognition of competences acquired outside formal education or acquired in professional experience and study results achieved in previous education at Riga Technical University” (only in Latvian). In the execution of preconditions, the Committee shall ascertain that the necessary prior knowledge has been acquired for the study courses. If the preconditions are not fulfilled, an individual study plan is created for the applicant, in which it is intended to achieve the necessary study learning outcomes before the commencement of studies, or in parallel with studies, if the amount of study courses to be acquired is small.

The admission requirements were confirmed by the decision of licensing decision of the Study Quality Commission (Nr. 2021/23-L, 30.06.2021.)

The studies are based on the PhD student's individual work plan, which is created considering the needs of the doctoral student and the specifics of the PhD Thesis. A model plan is used in the selection of study courses, but the student can create an individual plan, taking into account the interrelation of the study courses. Students have wide possibilities to independently plan the course of studies, including the mandatory study course "Scientific Seminars", in which the student establishes and coordinates the activities of the scientific seminar planned in the Scientific Committee of the FCSIT. The study course model plan is given in Annex 5.3. Annex 5.3.1 provides examples of individual study plan for applicants for a Doctor of Science (Ph.D.) degree in mathematics.

The PhD student plans to achieve the planned learning outcomes for the study courses "Scientific Seminars" and "Scientific Activity Practice" together with the PhD Thesis supervisor and coordinates it with the Scientific Committee of FCSIT. The work done in the study courses is registered in the implementation section of the work plan, and the implementation is approved by the Scientific Committee of FCSIT. The planned amount of work can be implemented in several semesters.



Evaluation of the learning outcomes at RTU takes place in accordance with the Regulations for the Evaluation of Learning Outcomes (https://www.rtu.lv/writable/public_files/RTU_1_studiju_rezultatu_vertesanas_nolikums.pdf (only in Latvian)) and the Regulations on PhD Studies at Riga Technical University (https://www.rtu.lv/writable/public_files/RTU_4.4._rtu_doktoranturas_nolikums_25062012.pdf (only in Latvian)). It is envisioned that examinations in compulsory study courses shall be taken in the presence of the examination committee consisting of not less than three persons, one of whom is the responsible instructor for the study course and the other - Doctor of Science.

The study program is implemented in Latvian and English. For admission to studying in English, the minimum level of knowledge of English is B2. The academic staff involved in the study program have appropriate knowledge of English.

The recommended number of students to simultaneously take the study courses in Part A is 15-20 students, which provides an opportunity to discuss results and exchange ideas and knowledge, covering the entire range of thematic areas of the study program. The recommended number of students at the study courses in Part B is from 8 students, therefore all Part B study courses will not be offered at the same time. It is planned to reach an appropriate number of students in the third year of implementation of the study program.

Mandatory study courses are delivered both in Latvian and English. Elective courses are delivered jointly for students from both Latvian and English variants of the study program if there are any English language students selecting the course. Delivery of the mandatory courses in Latvian ensure development of terminology. Latvian speaking students have had English in previous studies and are able to study in English. Joint studies promote cooperation and exchange among students from both study program delivery modes.

The didactic approach of the study program is based on a close link between study courses and research work. Within study courses, specific questions are considered through the prism of the field of the PhD Thesis, which allows students to view the problem of the study from different perspectives. For example, within DOP727 “Research Methods in Computer Science and Information

Technology” various research methods are acquired by analyzing their suitability for the topic of the PhD Thesis chosen by the student, and within DMI752 “Machine Learning and Data Mining for Data Analysis” students study the possibilities of using machine learning methods. The study courses offer active study opportunities to the students, preparing their research to be published, participating in seminars, working within research projects and engaging in other scientific activities (review, conference organizing, etc.).

For students of the existing PhD study program, the Scientific Committee of FCSIT will develop individual study plans that will allow them to participate in the new study program. The development of individual plans will consider the currently achieved learning outcomes, if necessary, additional study courses or parts thereof will be acquired. For students of the 3rd and 4th year studies, sections of Part A study courses will be evaluated individually, which need to be strengthened, taking into account the results of the PhD Thesis development.

Pedagogical methods, structure of the study courses and assessment methods shall be chosen by the responsible instructor of the study course according to the curriculum of the study course and the specifics of the study program, as well as the needs of students. For academic staff, courses and seminars on the latest teaching and pedagogical methods are organized, as well as the attendance of qualification improvement courses is promoted both at the internal events of the faculty, RTU and internationally. RTU Centre for Academic Excellence organizes academic staff advancement events at the university level. International qualification of academic staff is ensured by RTU participation in ERASMUS+ program –(https://www.rtu.lv/en/internationalization/mobility/erasmus-plus).

The specific assessment criteria of each study course must be introduced to students at the first lecture, they must also be published in the e-learning environment of the study course on RTU portal ORTUS.

The development of the PhD Thesis is controlled at two levels:

- meeting regularly with the supervisor of the PhD Thesis;
- reporting to the meeting of the Institute Council (first year students at least twice a semester, students of other courses - at least once a semester).

The study program is implemented in close cooperation with the supervisor of the PhD Thesis. In addition, there is an annual report to the councils of FCSIT institutes, as well as a PhD attestation at the end of the academic year (in accordance with the Regulations of Doctoral Studies at RTU). The mechanism for the implementation of this type of study program allows ensuring the achievement of learning outcomes.

PhD students shall be transferred in the next academic year by an order of the Dean of the Faculty, based on a decision of the Scientific Committee of the Faculty and taking into account the following minimum requirements towards publications and development of the PhD Thesis:

1. For a first-year PhD student:
    - One scientific article has been published or accepted for publication.
2. For a second-year PhD student:
    - One scientific article has been published.
    - One scientific article published or accepted for publication in a journal.
    - The doctoral thesis has been prepared in the amount of approximately 30% of the total amount of work.
3. For a third-year PhD student:
    - One scientific article has been published.
    - One scientific article in the journal has been published.

- The PhD Thesis has been developed in the amount of approximately 75% of the total volume of work.

RTU internal quality management system operates in accordance with the Excellence Approach approved by the RTU Senate on 30 January 2017 (Minutes No. 606; see: https://www.rtu.lv/en/university/strategy/rtu-excellence-approach), as well as the RTU Quality Policy approved on 25 September 2017 (Minutes No. 612; see: https://www.rtu.lv/writable/public_files/RTU_quality_policy_of_rtu.pdf).

The quality policy is aimed at the implementation of RTU mission and the achievement of strategic goals – scientific activity, studies, infrastructure, excellence and recognition of the organization. The quality policy forms the framework for the implementation of RTU strategy, research, study process and development and improvement of the organization. The university's quality policy is aligned with the standards and guidelines of the European Association for Quality Assurance in Higher Education (ENQA). RTU Excellence Approach and Quality Policy are mutually integrated documents that stipulate that RTU uses EFQM (European Foundation for Quality Management) as a quality model.

Since December 2018, RTU has become member of the European Quality Management Fund. RTU Excellence Approach has been created to promote the purposeful development of the university as an excellent organization and integrates the university's Constitution, Strategy and Quality Policy, its creation is based on the Standards and Guidelines for Quality developed by the European Association for Quality Assurance in Higher Education Assurance in European Higher Education Area, ESG and the EFQM Model of Excellence.

The structure of RTU Excellence Approach has been developed in accordance with EFQM model of excellence criteria and serves as the basis for maintaining a high level of performance at the university as a precondition for continuous improvement, as well as for achieving sustainable results and excellence of RTU activities. Student outcomes are a separate criterion, they are partly transferred to the main performance results as well, thus, the quality of the study field is closely intertwined with RTU quality management.

To analyze study fields and obtain feedback, RTU has developed a survey cycle:

- every semester a student survey in the study program is carried out on the quality of the extracurricular activities, work of the lecturers and the evaluation of the study program. The survey is conducted electronically in the ORTUS environment, the results are received by each member of academic staff in person and the head of the structural unit;
- after graduation, alumni questionnaires are carried out at Bachelor's and Master's level, regular questionnaires of employers are planned. The results are (will be) taken into account in the improvement of the programs within the study field;
- the annual survey of PhD students and PhD graduates has also been introduced, a survey on the admission of PhD students is planned, a survey on the admission process and the commencement of studies has been introduced.

In addition to the general quality management measures of RTU, Study Field Committees have been established, the duties and activities of which are regulated by the "Regulation of the Study Field Committees " (approved at the meeting of RTU Senate on 3 December 2012, Minutes No. 565, updated on 25 May 2015), see: https://www.rtu.lv/writable/public_files/RTU_studiju_reglaments_4.7._studiju_virziena_komisijas_nolikums_29.04.2019.pdf (only in Latvian). Study Field Committees shall supervise academic activities in the relevant study field and shall be responsible for the content and quality of the programs in the study field, including accreditation of the study field. The expert examination of the draft of the study program shall be carried out by the Study Field Committee, after that - by the council of the faculty or the councils of several involved faculties. This expert examination process is completed by the Study Department: Study Field Committee shall evaluate the quality of the draft of the study program, as well as the conformity of the content with the planned aim and tasks.

The student self-government of the faculty and its members, who are actively work in the decision-making bodies of the higher education institution, are also attracted to ensure the quality of the study field and the study programs implemented therein: RTU Academic Assembly, RTU Senate, RTU Senate Committees and Faculty Council.

In order to receive feedback within the study programs, student surveys are carried out, which are regulated by the Regulations "On Student Surveys in the Evaluation of the Study Process". Within the framework of the work of the Study Field Committee, recommendations of employers and external experts are analyzed and the relevant changes in study programs are made on their basis.

RTU Alumni Association has been established and is active in providing feedback from RTU graduates to the university (http://alumni.rtu.lv/, https://www.facebook.com/RTUAlumni/). The online community platform has been created https://rtuconnect.net/, it is aimed at developing alumni traditions.

3.2.4. If the study programme envisages an internship, describe the internship opportunities offered to students, provision and work organization, including whether the higher education institution/ college helps students to find an internship place. If the study programme is implemented in a foreign language, provide information on how internship opportunities are provided in a foreign language, including for foreign students. To provide analysis and evaluation of the connection of the tasks set for students during the internship included in the study programme with the learning outcomes of the study programme (if applicable).

3.2.5. Evaluation and description of the promotion opportunities and the promotion process provided to the students of the doctoral study programme (if applicable).

Students are provided with the opportunity to obtain a PhD degree. The viva voce of the PhD Thesis takes place in accordance with Cabinet Regulation No. 1001 (27 December 2005) "Procedures and Criteria for Granting a PhD degree" (https://likumi.lv/ta/id/124787-zinatniska-doktora-grada-pieskirsanas-promocijas-kartiba-un-kriteriji (only in Latvian)). The promotion process starts if the PhD student has successfully passed all examinations and credit tests specified in the PhD study work plan, as well as has developed the PhD Thesis. The next step is the submission of the PhD Thesis to the Doctoral Council of the relevant field for public viva voce examination. The organizational unit of RTU, where the PhD Thesis has been developed, decides at the meeting that the PhD Thesis has been developed and can be submitted to the Doctoral Council of the relevant field. An applicant for a scientific degree submits an extract from the minutes of the meeting together with other necessary documents. If the PhD Thesis complies with the requirements of the PhD degree, then the date of viva voce examination is appointed. Not later than 2 weeks before the date of viva voce examination of the

PhD Thesis specified by the Doctoral Council, the applicant for a scientific degree:

- which has already been exmatriculated from the PhD study program upon completion of the theoretical courses, submits an application addressed to the Doctoral Study Department to RTU Vice-Rector for Research requesting the readmission to the PhD study program;
- uploads the PhD Thesis, a summary of the PhD Thesis (in Latvian and English) and an electronic version of the annexes to the PhD Thesis on the portal ORTUS.
- submits 1 printed copy of the PhD Thesis and summary (in Latvian and English) to the RTU Library,
- submits 2 printed copies of the PhD Thesis and 7 copies of the summary (in Latvian and English) to the State National Library.
- Submits statements on the transfer of PhD Thesis and summaries to the libraries to the Secretary of the Doctoral Council prior to the viva voce examination.

At the end of the process, public viva voce examination of the PhD Thesis and the award of a scientific degree take place.

Depending on the degree to be obtained, the PhD Thesis is publicly presented:

- at the Doctoral Council «RTU P-07», which is entitled to award a doctorate in science (Ph.D.) in the sub-fields of electrical engineering, electronics, information and communication technology in computer control and system analysis, modelling and design;
- the Doctoral Council of the Field of Mathematical Sciences of the University of Latvia.

«RTU P-07» operates permanently. Prof. J. Grundspeņķis is the Chairman and V. Šakele is the Secretary. The Secretary of the Council and the Doctoral Department of RTU provide students with the necessary information about the promotion process.

RTU has entered into an agreement with the Doctoral Council of the Field of Mathematical Sciences of the University of Latvia on the provision of the opportunities for RTU students to obtain a doctorate.

3.2.6. Analysis and assessment of the topics of the final theses of the students, their relevance in the respective field, including the labour market, and the marks of the final theses.

The study program has been developed in accordance with the RTU Research Program and the FCSIT priority areas. FCSIT positions itself as a faculty of RTU, whose mission is to ensure the creation of new internationally competitive products and services for sustainable growth of the computer science and information technology sector, as well as education and training of specialists necessary for the national economy of Latvia - creative information technology developers. FCSIT vision is to become an internationally recognized science and innovation institution in the field of computer science and information technology by 2025. The aim of the FCSIT is to ensure excellent and internationally recognized research, an excellent and research-based study process and sustainable innovation and commercialization.

The priority areas of scientific activity are:

- comprehensive intellectual computing for evolving digital companies;
- comprehensive intelligence for the development of smart and autonomous systems and their integration;

- comprehensive data processing (communication, computing and control) in dispersed, complex environments;
- mathematical modelling.

The research areas are aligned with “Digital Europe” development areas at the European scale:

1. Artificial intelligence – special attention is paid to big data processing and machine learning technologies.
2. Cybersecurity – particular attention is paid to the use of data analysis and machine learning methods in cybersecurity and analysis of distributed systems.
3. High performance computing – ensures implementation of research in artificial intelligence, cybersecurity and digital transformation. Its capabilities are developed in cooperation with RTU High Performance Computing Centre.
4. Digital transformation – special attention is paid to the practical launch of technologies to digitize the processes of companies and organizations.

The themes of the PhD Theses will be primarily secured in the abovementioned research areas. The curriculum of the study program is designed to provide in-depth knowledge in these fields.

The table lists the PhD Theses defended in the study programs of the Faculty of Computer Science and Information Technology – "Computer Systems", "Information Technology" and "Automation and Computer Management" since 2013.

Research on autonomous robotic systems, which is one of the Digital Europe areas, plays an important role. Research is carried out in cooperation with the leading companies in this field. In the field of robotics, the research results provide the basis for the product of the start-up company Robotic Solutions, which in 2021 obtained a licensed for the multi-robot management system "Technical and production documentation of the multi-robot system, software". In the field of digital transformation, research on digital ecosystems is being carried out, including a study in cooperation with the company "ZZ Dats" and the innovation grant of a PhD student on user experience topics. In the field of big data technologies, two companies obtained a license for the "Implementation of the Vehicle Arrival Time Forecasting (TILP) Algorithm", the development of which was developed by a PhD student.

#	Title	Publication year
1	Software Testing Strategy Utilizing Lean Canvas Model	2022
2	A Development of Method for Code Generation from Two-Hemisphere Model	2021
3	Development of Computer-Based Diagnostic System in the Domain of Magnetic Resonance Applications	2021
4	Function Shaping in Deep Learning	2021
5	Development of a Scenario-Based Approach to Simulation Games Management	2021

6	Development of a Multi-Agent System for Supply Chain Management Performance Improvement	2021
7	Development of Knowledge Extraction Methodology from Trained Artificial Neural Networks	2020
8	Risk Forecast with Continuous Models for Evaluating Technology and Markets	2019
9	Implementation of the Pedagogical Module in the Emotionally Intelligent Tutoring System	2019
10	Intelligent Tutoring System for Assessment of Usage of Computer Aided Design Systems	2019
11	Forecasting System Development for Nonlinear and Nonstationary Time Series of Normalized Difference Vegetation Index	2019
12	Information System Change Assessment in the Context of Enterprise Architecture	2019
13	Development of Intelligent Data Retrieval Methodology	2018
14	Transport Travel Demand Model Development based on Machine Learning And Simulation Methods	2017
15	Shallow Flow Stability Analysis with Applications in Hydraulics	2016
16	Development of Methods and Algorithms for Bone Structure Radiological Image Analysis and 3d Visualization	2016
17	Development and Estimation of Wireless Sensor Network Life Expectancy Assessing Model and Methods	2016
18	Research on Impulse Radio's Feasibility for Wireless Sensor Network and Development of New Compatible Architecture	2016
19	Supporting Implementation of the Agile Paradigm in Software Development Companies	2016
20	The Research and Implementation of Personalized Study Planning as a Component of Pedagogical Module	2015
21	The Use of Personal Adaptive Behavior Profile for Detecting Anomalous Activity of Electronic Information System User	2015
22	The Integrated Domain Modeling: an Approach & Toolset for Acquiring a Topological Functioning Model	2015

23	The Development and Implementation of Model-Driven Software Configuration Management Solutions	2015
24	Development of Education Demand and Offer Information Monitoring System’s Model	2015
25	Applying Sensor Networks Technology in Time-critical Applications	2015
26	Fuzzy Classification Methodology for Processing and Analyzing Bioinformatics Data	2015
27	A System for Processing Short Time Series and Their Characteristic Parameters in Forecasting Tasks	2015
28	Evolutionary Induction of Decision Tree Classifier Ensembles Using Class Density Structures	2014
29	A Cooperative Interaction of Components in Wireless Sensor Networks	2014
30	The Development and Implementation of Hybrid Map Merging Method	2014
31	Modelling-Based Multi Echelon Supply Chain Tactical Management	2014
32	Personalization of Business Process Execution in Enterprise Applications	2014
33	Mobile Agents for Business Process Management Support in Cloud Computing Environments	2013
34	Development of Interactive Inductive Learning Based Classification System's Model	2013
35	Robust Time Series Forecasting Methods	2013
36	Simulation-Based Fitness Landscape Analysis and Optimisation of Complex Systems	2013

3.3. Resources and Provision of the Study Programme

3.3.1. Assessment of the compliance of the resources and provision (study provision, scientific support (if applicable), informative provision (including libraries), material and technical provision, and financial provision) with the conditions for the implementation of the study programme and the learning outcomes to be achieved by providing the respective examples.

The study process is ensured by academic and technical staff of FCSIT. FCSIT constantly renews and upgrades equipment of lecture halls and training laboratories, following the trends in the industry. Construction of the new FCSIT building is currently being completed. It is planned that studies in the new faculty building will be started in the academic year 2021/2022. The FCSIT building will comply with international standards and allow ensuring a high-quality study process. It will be located in RTU Campus in Ķīpsala, improving cooperation opportunities with specialists of other fields of science.

Organizational units of FCSIT and RTU are involved in the implementation of the study program:

- FCSIT ITI Department of Modelling and Simulation;
- FCSIT ITI Department of Management Information Technology;
- FCSIT LDI Department of Applied Computer Science;
- FCSIT LDI Department of Software Engineering;
- FCSIT LDI Department of Artificial Intelligence and Systems Engineering;
- FCSIT LMI Department of Engineering Mathematics;
- FCSIT LMI Department of Probability Theory and Mathematical Statistics;
- FCSIT NSA Department of Computer Graphics and Computer Vision;
- Department of Computer Management and Computer Networks of the FCSIT NSA;
- BIF Department of Water Engineering and Technology.

RTU institutes and their departments ensure the training and methodological work: develop and update the curriculum, provide delivery of corresponding study courses, supervision and examination of PhD theses and carry out other activities related to teaching, methodological and research work. Elective study courses are offered also by other organizational units of RTU and other higher educational establishments.

The study program is granted with assistance of the general RTU support staff, which provides the functioning of the infrastructure.

Practical implementation of the study program requires professional administrative staff consisting of academic work manager, office manager or record keeper and auxiliary staff (the number of specific employees depends on the number of students in the program), including staff from RTU International Cooperation and Foreign Students Department.

RTU students and academic staff can also use the modern computing infrastructure of RTU HPC (High Performance Computing) Centre or Scientific Computing Centre (http://hpc.rtu.lv/), including RTU supercomputer and scientific software.

RTU Doctoral Department provides administrative assistance for the PhD study process and promotion for the doctorate.

The infrastructure and material and technical resource base available for the implementation of the study program, thanks to the high level of digitization, provide an opportunity to increase competitiveness, quality and efficiency of the university, as well as ensures availability of information by integrating IT solutions into the administrative, study and scientific work processes of the university, providing students, administrative and academic staff with modern, reliable, safe and unified IT infrastructure, and high-quality IT services.

Various teaching and learning methods are used within the study courses in the study program, including:

- lectures, seminars, colloquiums and practical classes;
- use of modules and intensive studies;
- learning by doing research and PhD student peer learning approach;

- independent scientific work.

The informative and methodological basis necessary for the implementation of studies includes:

- RTU Doctoral School's open resources on PhD studies and RTU Doctoral Student's Manual;
- bibliographical resources provided by RTU Scientific Library;
- learning tools, including remote studies and collaboration tools, such as Office 365, Mendeley, Miro, and JIRA;
- computing resources provided by RTU High Performance Computing Centre and FCSIT cloud computing CloudStack platform created within the ERDF project «(IKSA-CENTRS) Creation of information, communication and signal processing technology national research center». Students also have access to the Microsoft Azure cloud environment;
- software resources, for the acquisition of which the use of open-source technologies is facilitated and contracts are concluded for the free use of software in research, e.g., contracts with MatLab, CPLEX, Microsoft, SAP, JetBrains, JIRA. If necessary, additional software and computing resources may be purchased at the expense of the organizational unit;
- Open-source software is widely used, including Linux, Docker, Kubernetes, Python, R and others, depending on the research specifics.

PhD students have at their disposal six FCSIT scientific laboratories, including the national research center IKSA, which houses technical support for research work (e.g., 3D printers, etc.), the Imaging and Computer Graphics Laboratory, and the Embedded Systems and Sensor Networks Laboratory, where drones are created and microprocessors are programmed. FCSIT students also use the opportunities of RTU Design Factory.

RTU offers wide opportunities to participate in international mobility: 1) Erasmus+ program; 2) Nordtek and BALTECH programs; 3) specialized cooperation programs and 4) project funding.

In order to provide simple and effective identification of IT users, the IT user identity management system has been introduced, and as a result, each IT user has a unique electronic identity created and maintained, and made valid in all information systems. In addition to the mentioned above, a user session management system in IT systems is provided, where at one single application in RTU information systems, IT users do not need a repeated authorization. This offers the user experience of a joint integrated information system, which remembers various identification data and inputs it again to implement different scenarios of IT application.

All IT users are provided with access to the centralized portal ORTUS (https://ortus.rtu.lv/), which functions as a single digital gateway, collecting the information from all components of RTU information systems and providing users with a comfortable and simple user experience and convenient access to the catalogue of all IT services in the same place.

For effective administration of studies, the centralized management system is used (https://stud.rtu.lv/rtu/), which ensures digital security of studies lifecycle, including the electronic register of study programs (https://stud.rtu.lv/rtu/vaaApp/sprpub - public part), elaboration of study agreements and enrolment of applicants in the study programs, the study course register (https://info.rtu.lv/rtupub/disc2/list - public part), development of individual study plans, drafting of orders, study courses and training, input of grades, transfers, awarding qualifications, administration of payments, university hostel information board, preparation of diploma information, etc. This system serves as one of the cornerstones in administration of the study process.

In order to ensure efficient study process, “Moodle” e-learning environment is used, where all binding information is generated automatically (study courses, users, groups, rights of access, etc.). This system ensures student-instructor communication. In the system, the academic staff place e-materials, competence tests, home tasks, information about a certain study course, etc. On ORTUS portal students can see their financial information, make requests for documents (certificates, academic records, copies of the agreement, etc.). Academic staff of RTU is provided with “Zoom” and “Microsoft Teams” video conference platforms for online training.

Since 2007, more than 130,000 unique study course sites have been generated in the RTU e-learning environment. Students can connect and access electronic learning tools at anytime, anywhere.

Digitalization of classroom spaces and schedules has been carried out for efficient premise management and lecture scheduling (https://telpas.rtu.lv; https://nodarbibas.rtu.lv/). Every RTU student and academic staff can view their schedule, where they can see the place, time, faculty, room, class title and type of lesson for each class. Apart from ensuring user convenience, the system significantly facilitates the process of planning and scheduling classes, as well as optimizes premise occupancy and usage efficiency.

Electronic personnel management and record-keeping systems are also used for the efficient conduct of administrative work, which cover the circulation of record-keeping and personnel documents at RTU (https://docs.rtu.lv/). Electronic document coordination and document e-signing functionality have been introduced, thus reducing printout-based document circulation, as well as improving the speed of document circulation. Since admission round in autumn 2019, students sign learning arguments electronically. Since 2016, graduates have been receiving grade transcripts in the form of an electronically signed document.

For quality assurance purposes, a digital student survey system is used, which is used to control the quality of implementation of individual study courses and study programs. Based on the results of quality control, regular measures are taken to improve study programs and processes.

For additional convenience of RTU students, academic staff and employees, RTU leases “Microsoft Windows” and “Microsoft Office” software, which provides all users with the access to the latest and up-to-date Microsoft software. RTU students can also use RTU provided licensed operation system Windows and the productivity package Microsoft Office for learning needs. All RTU users are provided with the access to Microsoft Office 365 cloud computing platform with 1TB data storage disk space and access to different supplementary co-working and productivity tools (Microsoft Teams, SharePoint Online, Forms, OneNote, OneDrive, Outlook, etc.) available for each user. RTU students, academic staff and employees have access to the university e-mail service.

In support of scientific processes, a centralized Science Support System is provided, where all information on publications, patents, applications for commercialization, PhD theses, RTU scientific journals, scientific staff, etc., is registered. The system provides access to information on the basis of the OpenAccess principle (https://science.rtu.lv). In addition, RTU students and faculty have centralized access to scientific software.

RTU maintains high-speed optical internet and extensive wireless network infrastructure with more than 400 access points, including the international service *Eduroam.*

In addition, desktop phones and mobile communications are provided for fast and convenient communication.

In order to ensure stable and safe operation of the IT infrastructure, continuous monitoring of IT infrastructure and systems is carried out, as a result of which proactive incident control is carried out. Backup copies of data are created.

The University has developed and implemented the Information Systems Security Policy, the main purpose of which is RTU information system use security, introducing and maintaining a sufficient set of measures for the reduction or prevention of potential or caused harm. The implementation of the IT security policy includes security checks, monitoring of the data transmission network and taking preventive measures. Regular IT security and personal data protection training for IT users is organized. Automated security incident management and risk management are in place. Statistics shows that the number of IT security incidents has decreased significantly over the last five years.

The IT User Support Centre provides IT user support and one-stop processing of applications based on ITIL guidelines. Since 2007, the IT User Support Centre has processed and resolved more than 160,000 IT user applications.

The Scientific Library of RTU is an academic library of state significance, which has obtained its status as a result of library accreditation. The Scientific Library of RTU provides the necessary information for RTU study process and research activities, performs library, bibliographic and information services for RTU students, teaching staff, and employees. The Library's collection includes 1.3 million printed documents and e-resources in the databases relevant to RTU fields. The collection is stored in the Central Library, the Study Literature Subscription Office, the Chemistry Collection, the Transport Collection and the Study and Research Centers in Daugavpils, Liepāja, Cēsis and Ventspils.

In 2016, significant investment was made in the development of the library infrastructure, with the construction of an additional 2240 m2 of space for the Central Library. The total area of the library premises is 6393 m2, of which 3417 m2 are for reader services. There are 713 workstations for library users. The library has four group rooms and six individual cubicles, a rare edition reading room and a conference room. The library is accessible to users with reduced mobility.

In order to improve the SL activities and to meet the information needs of academic and research staff, the Library Council has been established, which decides on replenishing the library collection with printed publications and subscribing to the necessary databases. The Library Council has approved the Compilation Policy of RTU SL Collection, which sets the basic principles of the collection development in accordance with the areas of RTU academic and research activities.

When RTU provides funding for the library, the funding for information resources for each study program is calculated. The collection is replenished according to the recommendations of the heads of study program, researchers, in compliance with the allocated funding. By contacting the SL Collection Development Department regarding replenishment of collection, the desired editions can be ordered at the Library website by filling out an order form (https://www.rtu.lv/lv/studijas/biblioteka/pakalpojumi-3 (only in Latvian), library's English language web site is https://www.rtu.lv/en/studies/scientific-library), an application form, contacting by phone 67089353, or visiting the Library at 5-105 Paula Valdena Street. The SL offers a guide, which includes websites of various Latvian and foreign publishing houses and bookstores for searching publications and e-resources.

Database subscription agreements are concluded both directly with the supplier and through the Cultural Information Systems Centre, which is the Latvian national representative for the international non-profit organization Electronic Information for Libraries (EIFL http://www.eifl.net/). The EIFL Licensing Programme offers libraries of state importance to subscribe to internationally recognized databases at a significantly reduced subscription fee that is not offered to individual subscribers, thus saving the financial resources of the libraries.

Every month, the list of the newly-received literature is published in the SL newly-received literature bulletin (https://www.rtu.lv/lv/studijas/biblioteka/jaunieguvumi (only in Latvian)).

The database subscriptions maintained by RTU Scientific Library (https://www.rtu.lv/en/studies/scientific-library/electronic-resources):

- ProQuest Ebook Central, Academic Search Complete EBSCOhost, Applied Science & Technology Source EBSCOhost, Business Source Ultimate EBSCOhost, EBSCOhost eBook Academic Collection, Wiley Online Library, SpringerLink, The International Monetary Fund.
- Databases financed by the Ministry of Education and Science available to RTU Scientific Library: ScienceDirect, SCOPUS (Elsevier), Web of Science.
- Latvian databases: LETA, Letonika, the Database of Latvian Standards (available on the premises of the Library).

Database usage at the Scientific Library of RTU has been growing since 2016.

The new library premises have allowed to extend the range of services. Since the opening of the new premises in 2018, the number of visits to the library has increased from 103,825 to 691,200. The Central Library is open to users from Monday to Saturday (https://www.rtu.lv/writable/public_files/RTU_library_general_info_summer_2022.pdf). There is a 24/7 reading room. During the summer period, the Central Library is open every weekday with reduced opening hours.

The SL information sources are provided in the open access. Books and periodicals relevant for the study fields are located in the main building of the Scientific Library (5 Paula Valdena Street) in compliance with UDC indexes. The last copy of the oldest editions that comply with RTU profile is stored in the library repository. They are always available to users.

The on-duty librarian helps find the necessary resources. More detailed information and consultations are provided by bibliographers. The SL has librarians responsible for particular fields of science (https://www.rtu.lv/lv/studijas/biblioteka/nozaru-informacija (only in Latvian)).

Searching for library resources is ensured by the Primo Discovery search tool (https://primolatvija.hosted.exlibrisgroup.com/primo-explore/search?sortby=rank&vid=371KISCRTU_VU1&lang=en_US). It allows searching for the information in the library catalog (https://kopkatalogs.lv/F/?func=find-b-0&local_base=rtu01), subscribed databases, as well as in databases created by the Scientific Library (https://www.rtu.lv/lv/studijas/biblioteka/informacijas-meklesana/datubazes-eresursi/bibliotekas-veidotas-datubazes). Searching for the information in the joint electronic catalog (https://kopkatalogs.lv/F), one can simultaneously obtain information about the available resources in 12 libraries in Latvia. Both the electronic catalog and RTU portal ORTUS can be used to reserve the library resources remotely. Remote access to databases is also provided. Since the introduction of RFID technology, users have been able to use five book-dispensing self-service vending machines and return books to a book-sorting vending machine around the clock. Book usage term can be prolonged remotely.

The SL provides students, academic staff and other stakeholders with different types of individual consultations and group training in information literacy (https://www.rtu.lv/en/studies/biblioteka/lietotaju-apmacibas).

Editions that are not available in the Scientific Library are delivered through an interlibrary subscription or international subscription. Internet access is provided throughout the Library. The SL provides copying, scanning, printing and binding services, there is also a self-service canteen.

The SL can be contacted via: Ask the Librarian, using information e-mail, calling to the information phone number (https://www.rtu.lv/en/studies/scientific-library).

3.3.2. Assessment of the study provision and scientific base support, including the resources provided within the framework of cooperation with other science institutes and higher education institutions (applicable to doctoral study programmes) (if applicable).

The scientific basis and infrastructure are provided by FCSIT, which is one of the largest and most vigorous research institution in Latvia in the area of computer science and information technology.

The **main infrastructure** objects available at FCSIT:

- The necessary infrastructure for the projects is available at the Information, Communication and Signal Processing Technologies Research Centre of National Significance (ICSPT RCNS): scientific infrastructure and administrative facilities of the total area of more than 800m^2 for research activities, including individual working places for researchers and PhD students equipped with advanced computing stations for parallel computing, meeting rooms equipped with modern presentation and communication devices, equipment/electronic design laboratory. The center supports most research connected to AI, Robotics, Software Engineering. FCSIT has set ICSPT RCNS as the main scientific infrastructure object, which since its establishment shows good performance in attracting external funding and delivering scientific results. Current FCSIT plan is to ensure full operation of the ICSPT RCNS and expand when relocated to the new building.
- Dedicated facilities for autonomous robots and drone experiments. RTU High Performance Computing Center is available for researchers. Series of up-to-date scientific infrastructure: CRT machine, 3D printer, oscilloscopes and other measurement instruments, soldering stations, power suppliers, cameras, embedded devices for R&D, passive and active electronic components, etc.
- Electronics prototyping equipment: PCB milling machines, PCB stencil application machine, PCB reflow oven, soldering equipment (including hot air), electronics laboratory equipment, CNC lathe and milling machines with 5th axis, room for mechanical assembly and repairs (mechanical tools, welding equipment), 1 Gbit LAN in all RTU infrastructure objects, Wi-Fi network.

Infrastructure available through RTU centralized services:

- Design factory (DF), which is the major prototyping center of RTU located in the main campus. The center comprises large scale wood, plastics, metal and electronics prototyping facilities. RTU is the 2nd largest plastics 3D printing center in the region, providing access to several 3D printing technologies including polyjet printing;
- Academic network connecting all research and academic institutions in Latvia enabling access to internet and intranet resources including electronic library resources. 1 Gb/s LAN is available throughout the campus.

Most of the available infrastructure is open-access, which means that it can be used by any researcher within FCSIT or any other RTU department. According to RTU regulations, a fraction of all external income is allocated for maintenance and upgrade of the existing or development of new infrastructure. The regulations are part of the RTU's long term strategy and resource planning, ensuring availability of the infrastructure.

There are about 63 FTE people involved in research activities at FCSIT. The number of researchers has been relatively stable.

	2013	2014	2015	2016	2017	2018	
Academic personnel	**33.15**	**38.84**	**37.68**	**38.04**	**35.05**	**32.72**	
Professors	14.77	15.63	14.19	13.17	13.17	12.26	
Associated Professors	6.62	10.89	8.66	9.07	7.76	7.74	
Assistant Professors	11.76	12.32	14.83	15.8	14.12	12.72	
Academic research personnel	**27.18**	**22.3**	**26.42**	**27.06**	**31.89**	**29.67**	
Leading researchers	4.65	4.86	9.64	7.69	10.81	10.96	
Researchers	16.96	11.34	9.88	11.12	12.05	10.85	
Research assistants	5.57	6.1	6.9	8.25	9.03	7.86	

3.3.3. Indicate data on the available funding for the corresponding study programme, its funding sources and their use for the development of the study programme. Provide information on the costs per one student within this study programme, indicating the items included in the cost calculation and the percentage distribution of funding between the specified items. The minimum number of students in the study programme in order to ensure the profitability of the study programme (indicating separately the information on each language, type and form of the study programme implementation).

RTU funding from the basic state budget is made up of the study base financing corresponding to the list of study programs and the number of students; it is used to cover such expenses as utilities, taxes, infrastructure maintenance (including data for the Student and Graduate Register), purchase of equipment and supplies, staff remuneration, and funding for research activities.

The number of study seats is allocated after discussions with the Ministry of Education and Science. Funding from the state budget is allocated for full-time studies. The amount of study base funding is determined on the basis of the number of study seats determined by the state at RTU, as well as the state-defined study seat basic expenses and study cost coefficients in the thematic areas of education.

Study cost coefficients for thematic areas of education are indicators that determine the amount of study seat costs in the respective thematic area of education in relation to the basic costs of the study seat.

The cost coefficients for the study programs in the thematic areas of education for Bachelor and professional study programs are set by in Annex 1 of Cabinet Regulations of 12 December 2006 “Procedure for Financing Higher Education Institutions and Colleges from the State Budget” (https://likumi.lv/ta/id/149900 (only in Latvian) (further in the text - the Regulations).

Values of study cost coefficients are 1.5 times higher for Master study programs and three times higher for PhD programs than the study cost coefficients specified in Annex 1 to the Regulations for the respective thematic area of education.

The amount of the study funding granted to the institution of higher education or college from the state budget for the implementation of Bachelor, professional and Master study programs is calculated using the following formula:

Fs = Tb x [S(ki x ni) + 1,5 x S(ki x mi)] + Sb x S(ni + mi), where

Fs – amount of study financing;

Tb – basic costs of the study seat;

ki – coefficient of the study costs in the relevant field of education (Annex 1 to the Regulations);

ni – the number of study seats for a higher education institution or college at undergraduate and professional study programs in the relevant thematic area of education;

mi – the number of study seats at the Master study programs in the relevant thematic area of education;

Sb – study seat social security expenses at undergraduate, professional and Master study programs (Annex 2 to the Regulations).

The basic costs of a study seat and the social security expenses of a study seat are determined in accordance with Annex 2 to the Regulations.

Each year, the Ministry of Education and Science calculates the basic costs of a study seat for the following budget year and, by November 1 of the current year, coordinates the calculations with the Ministry of Finance and those Ministries which have higher educational institutions and colleges subordinated to them.

RTU funding from the state basic budget for the provision of study seats in the respective academic year is distributed in accordance with the decision of RTU Senate “Methodology for the allocation and use of funding for the structural units of RTU” (hereinafter – the Methodology). The Methodology is reviewed and revised every year and is subject to the necessary changes.

RTU has a decentralized budget, and each organizational unit is allocated a separate budget. In a general sense, a budget is a plan of revenues and expenditures for a specific period of time, work, event or function. The revenues and expenditures of RTU shall be administered in accordance with principles approved by the Senate or as stipulated by the Vice-Rector for Finance.

According to the Budget Allocation Methodology, the financing is allocated to the organizational units either according to the financial or budget year or immediately after receiving the financing. The financial or budget year of RTU organizational units is from October to September of the following year, and for this period the financing is calculated and distributed:

- Subsidy or basic budget funding (training of state budget funded students) is divided into monthly limit – 1/12 of the estimated annual funding per month is allocated to the organizational unit;
- Tuition fee funding (training of tuition fee-paying students, including funding paid by students for settling academic arrears) is allocated twice a year (in October and April) as a monthly

limit – 1/6 of the estimated funding per semester is allocated to the unit monthly;
- Performance funding (research support funding) is allocated as a monthly limit – 1/12 of the estimated annual funding is allocated to the unit per month;
- Research base funding (research support funding) is allocated as a monthly limit – 1/12 of the estimated annual funding is allocated to the unit per month;
- foreign student tuition fee funding is distributed four times a year, taking into account that the largest amount of the planned workload is allocated to the organizational unit at the beginning of each semester (in October and April), the remaining part of funding – at the end of the semester.

Each head of RTU organizational unit is provided with remote access to operational financial information on the unit's budget, including the envisaged workload and correspondingly allocated funding for the implementation of study programs and study courses in subsequent periods. Based on this information, the head of the organizational unit plans the work of the unit at the beginning of each financial or budget year, including remuneration issues for academic staff members who are subordinate to the head of the unit, and develops a procurement plan for the following year in compliance with the implementation and development of the study program or study course, etc.

In addition to the seats financed by the state basic budget, the study program financing also consists of tuition fee revenue from the resources of natural or legal persons, which can be divided into two subgroups:

1. revenue from local fee-paying students;
2. revenue from foreign fee-paying students.

Funding from local fee-paying students is allocated in compliance with the Methodology where, in order to provide greater opportunities for the development of fee-based study programs, for several academic years, a significant amount of the funding received has been channeled to the Head of the study program, who may appropriately use this funding to renew facilities and attract higher level specialists for the implementation of the study process, etc.

Funding from foreign fee-paying students in a respective academic year is allocated in accordance with the Resolution of RTU Senate On Approval of the "Methodology for Allocation of Funds for Study Process Provision at the International Cooperation and Foreign Students Department" in the respective academic year.

Analyzing the financing procedure of the study programs and the study directions at RTU as a whole, it can be seen that the state basic budget and local fee-paying student funding in the long run are determined taking into account the basic principles established by the state. In the process of determining the amount of funding, the study cost coefficients of the thematic areas of studies and the values of the study cost coefficients according to the level of the study program, as well as the number of students at the study program and the study courses implemented therein are taken into account. As mentioned above, by using study cost coefficients of the thematic areas of studies, it is possible to determine the amount of financing required for the implementation of a particular study program and study course. In the Methodology for academic year 2018/2019, RTU Senate approved that in the future the study cost coefficients of the thematic areas of studies would be applied individually to each study course of the study program, thus ensuring even more appropriate amount of financing for the implementation of study courses included in the study programs. In order to implement this system, the Expert Committee was established by order of the Vice-Rector for Academic Affairs, who determined thematic areas of studies for each study course. RTU has the following thematic areas of studies and the applicable coefficients:

Thematic area of RTU study courses	RTU coefficient
Computer science	2.9
Mathematics and statistics	2.9

In order to ensure the functioning and sustainable development of the study programs, RTU has been improving the Methodology for each academic year in accordance with changes in the external and internal environment, thus also eliminating possible risks in the implementation process of the study program or its study courses. The transition process involves all stakeholders, thus ensuring transparency, as well as a transparent decision-making process. The required changes are at first initiated by RTU Vice-Rector for Finance, and additional changes can be initiated by any RTU employee by submitting a request to RTU Vice-Rector for Finance or to the Finance and Budget Committee of RTU Senate.

The total funding of the program reaches about 320 000 EUR/year. The bulk of the funding is for the Latvian language variant. The funding increases gradually though it is still significantly less than the optimal funding which was calculated as EUR 13 388,43 per student for academic year 2020/2021. The minimum number of students in the study program is 20 and at least 8 new students should be admitted every year. The minimum number of students is determined jointly of both delivery forms (Latvian and English) because most of the studies are taking place jointly and scientific work is individual.

Year	Latvian lang	English lang	Total
2013	265 035.00	0.00	265 035.00
2014	231 261.71	0.00	231 261.71
2015	179 015.17	0.00	179 015.17
2016	208 965.39	2616.86	211 582.25
2017	213 027.95	5517.87	218 545.82
2018	206 101.09	5618.64	211 719.73
2019	298 235.19	9632.48	307 867.67
2020	315 982.64	3463.71	319 446.35

Information on the minimum number of students in RTU study programmes is provided in the appendix of the self-evaluation report "On minimal number of students in study programmes".

Information on the funding distribution between the cost items is provided in the appendix of the self-assessment report "Funding distribution between the cost items".

3.4. Teaching Staff

3.4.1. Assessment of the compliance of the qualification of the teaching staff members

(academic staff members, visiting professors, visiting associate professors, visiting docents, visiting lecturers, and visiting assistants) involved in the implementation of the study programme with the conditions for the implementation of the study programme and the provisions set out in the respective regulatory enactments. Provide information on how the qualification of the teaching staff members contributes to the achievement of the learning outcomes.

30 Doctors of Science participate in the implementation of the study program, 19 of which are experts of the Latvian Council of Science. 14 professors participate in the implementation of the study program - Doctors of Science, who have been elected as professors by the Council of Professors and whose scientific and pedagogical qualification conforms to the criteria laid down in the laws and regulations regarding the assessment of the scientific and pedagogical qualification of the applicant for the position of professor. 11 elected associate professors participate in the implementation of the study program - Doctors of Science, who have been elected as associate professors by the Council of Professors and whose scientific and pedagogical qualification conforms to the laws and regulations regarding evaluation of scientific and pedagogical qualification of the applicant for the position of associate professor the criteria set out in the Regulation.

No	Name/ Surname	Degree	Position	Implemented study courses	LCS experts	*h*-index
1.	Alla Anohina - Naumeca	Dr.sc.ing. Dr.paed.	assoc. professor	DDD700, DDD701	Engineering and Technology*	11
2.	Dmitrijs Bļizņuks	Dr.sc.ing.	assoc. professor	DDD700, DDD701, DST718	Engineering and Technology*	4
3.	Katrīna Boločko	Dr.sc.ing.	assoc. professor	DDD700, DDD701, DDR601	Engineering and Technology*	2
4.	Nataļja Budkina	Dr. math.	assoc. professor	DDD700, DDD701	-	4
5.	Ingars Eriņš	Dr.oec.	professor	DDD700, DDD701	Social Sciences - Economics and Business Natural Sciences- Computer Science and Informatics	3
6.	Egils Ginters	Dr.sc.ing.	professor	DDD700, DDD701	Engineering and Technology*	7
7.	Jānis Grabis	Dr.sc.ing.	professor	DDD700, DDD701, DOP727 DOP729	Engineering and Technology*	19

No	Name/ Surname	Degree	Position	Implemented study courses	LCS experts	*h*-index
8.	Jānis Grundspeņķis**	Dr.sc.ing.	professor	DDD700, DDD701, DSP638	Engineering and Technology*	18
9.	Larisa Iļinska	Dr. philol.	professor	VSL711	Humanities and Arts – Linguistics and Literature	C2
10.	Tālis Juhna	Dr.sc.ing.	professor	LUK722	Engineering and Technology	17
11.	Jānis Kampars	Dr.sc.ing.	assoc. professor	DDD700, DDD701	Natural Sciences - Computer Sccience and Informatics	6
12.	Mārīte Kirikova	Dr.sc.ing.	professor	DDD700, DDD701	Engineering and Technology*	14
13.	Arnis Kiršners	Dr.sc.ing.	assistant professor	DDD700	Natural Sciences - Computer Science and Informatics	4
14.	Valentīna Koliškina**	Dr.mat.	assistant professor	DDD700	Natural Sciences- Mathematics	3
15.	Andrejs Koliškins	Dr.mat.	professor	DIM780 DDD700	Natural Sciences- Mathematics	11
16.	Egons Lavendelis	Dr.sc.ing.	assoc. professor	DDD700, DDD701	Engineering and Technology*	7
17.	Arnis Lektauers**	Dr.sc.ing.	assoc. professor	DDD700, DDD701	Engineering and Technology*	4
18.	Zigurds Markovičs	Dr.inž.	professor	DDD700, DDD701	-	2
19.	Andrejs Matvejevs	Dr.sc.ing.	professor	DDD700, DDD701	-	2
20.	Jurijs Merkurjevs	Dr.inž.habil	professor	DDD700, DDD701	Engineering and Technology*	6
21.	Ērika Nazaruka**	Dr.sc.ing.	assoc. professor	DDD700, DDD701, DPI737	Engineering and Technology*	4

No	Name/ Surname	Degree	Position	Implemented study courses	LCS experts	*h*-index
22.	Oksana Ņikiforova**	Dr.inž.	professor	DDD700, DDD701	Engineering and Technology*	10
23.	Agris Ņikitenko	Dr.sc.ing.	professor	DDD700, DDD701, DSP795	Engineering and Technology*	5
24.	Oksana Pavļenko	Dr.math.	assoc. professor	DDD700, DDD701, DMS603	-	7
25.	Jeļena Pečerska	Dr.sc.ing.	assoc. professor	DDD700, DDD701, DMI722	-	2
26.	Inese Poļaka	Dr.sc.ing	assist.prof.	DDD700, DDD701, DMI725	Engineering and Technology*	5
27.	Andrejs Romānovs	Dr.sc.ing.	assoc. professor	DDD700, DDD701	Natural Sciences - Computer Science and Informatics	5
28.	Felikss Sadirbajevs	Dr. math. habil.	professor	DDD700	Natural Sciences- Mathematics	6
29.	Marina Uhanova	Dr.sc.ing	professor	DDD700, DDD701	Engineering and Technology*	3
30.	Inta Volodko	Dr.math.	professor	DDD700, DDD701	-	3

* Engineering and Technology - Electrical engineering, electronics, information and communication technologies

** The application has been submitted/is being prepared for submission to the Latvian Council of Science.

The biographies of the academic staff reflecting their creative and scientific activity (Curriculum Vitae) are attached in Annex 5.8.

The following qualitative and quantitative indicators testify to the compliance of the qualification of the academic staff with the requirements specified in Section 55 of the Law on Higher Education Institutions : 14 professors and 11 associate professors participate in the implementation of the study program - Doctors of Science who have been elected as professors by the Council of Professors of Electronics, Information and Communication Technology, Computer Science and Computer Science or Mathematics and whose scientific and pedagogical qualification conforms to the criteria for the assessment of the applicant's scientific and pedagogical qualification laid down in the laws and regulations regarding the position of professors.

The academic staff involved in the implementation of the study program regularly improve the curriculum of the study courses and update the study materials. The methods of study organization are regularly reviewed and evaluated. The study courses were developed in close cooperation with the companies. An industry-oriented approach will be implemented in the practical and laboratory classes within the framework of the study courses. Academic staff have the opportunity to improve their professional knowledge and gain valuable experience in one of the foreign universities in accordance with the development strategy of the European Higher Education Area. Three assistant professors are also involved in the study program, who will soon apply for the position of associate professor and participate in the continuous process of renewal and replenishment of the academic staff.

3.4.2. Analysis and assessment of the changes to the composition of the teaching staff over the reporting period and their impact on the study quality.

No changes in the composition of academic staff have taken place during the reporting period, since the study program was started in academic year 2021/2022. Taking into account that the study program continues the previous traditions of PhD studies at the Faculty of Computer Science and Information Technology, the comparison can be made with these study programs.

During the evaluation period, one of the tasks has been to update the composition of the academic staff, which has been successfully completed, and the retired colleagues have been replaced with new qualified academic staff. At the beginning of academic year 2016/2017, the average age of the elected academic staff involved in the study program was 55.4 years, but at the beginning of academic year 2021/2022 it was 51.4 years. In general, the composition of the academic staff during the reporting period is assessed as stable. During the reporting period, several associate professors have been elected for the first time, e.g., assoc. prof. Katrina Btočko (2016), assoc. prof. Dmitrijs Bļizņuks (2017), assoc. prof. Ērika Asņina (2018), assoc. prof. Jānis Kampars (2018) and assoc. prof. Inese Poļaka (2020). In 2016, a young professor Egils Ginters started working at the study program. Seven professors terminated their activities during the reporting period. Overall, the number of professors as a result of generational change has decreased during the reporting period, but the number of associate professors who previously held the position of assistant professors has increased. The total number of responsible instructors involved has been stable during the reporting period. Compared to the previous PhD study programs, the share of associate professors has increased due to generational change. This has contributed to a faster updating of scientific activities, and several associate professors will be able to apply for professorships in the nearest future. In 2022, an international competition for the position of a tenured professor in artificial intelligence and cybersecurity has been announced, and, if selection process is successful, it will significantly contribute to the composition of the academic staff.

Year	Professors	Associate professors
2013/2014	17	8
2021/2022	14	11

3.4.3. Information on the number of the scientific publications of the academic staff members, involved in the implementation of doctoral study programme, as published during the reporting period by listing the most significant publications published in Scopus or WoS CC indexed journals. As for the social sciences, humanitarian sciences, and the science of art, the scientific publications published in ERIH+ indexed journals or peer-reviewed monographs may be additionally specified. Information on the teaching staff included in the database of experts of the Latvian Council of Science in the relevant field of science (total number, name of the lecturer, field of science in which the teaching staff has the status of an expert and expiration date of the Latvian Council of Science expert) (if applicable).

During the reporting period, the academic staff involved in the study program and the researchers of the FCSIT have published an average of 180 publications per year. During this time, the number of works indexed in Web of Science and Scopus has increased significantly, but the number of non-indexed data has decreased. Currently, there is a tendency that the total number of publications is decreasing, but the number of articles published in journals is increasing, because RTU Strategy is to focus on the development of journal publications, which would also contribute to increasing the citation index of scientific publications.

FCSIT also publishes two scientific journals, Applied Computer Systems and Information Technology and Management Science. Applied Computer Systems has been indexed in WoS since 2018 and 43 scientific publications have been published in the journal.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Articles (full text publications) in peer reviewed scientific edited journals and conference proceedings included in Web of Science or SCOPUS databases	41	67	86	98	129	98
Articles in peer reviewed scientific edited journals and conference proceedings not included in Web of Science or SCOPUS databases	138	127	98	80	51	71
Defended PhD theses	4	5	8	5	1	1
Monographs	3	3	4	3	4	3
Other scientific publications [1)]	5	2	1	7	2	3
Text books and other research-related publications	-	2	2	1	3	-

The list of publications published in the journals indexed in Scopus or WoS:

Ardavs, A., Pudane, M., Lavendelis, E. & Nikitenko, A. 2019, "Long-term adaptivity in distributed intelligent systems: Study of viabots in a simulated environment", Robotics, vol. 8, no. 2.

Berziša, S., Bravos, G., Gonzalez, T.C., Czubayko, U., España, S., Grabis, J., Henkel, M., Jokste, L., Kampars, J., Koç, H., Kuhr, J.-., Llorca, C., Loucopoulos, P., Pascual, R.J., Pastor, O., Sandkuhl, K., Simic, H., Stirna, J., Valverde, F.G. & Zdravkovic, J. 2015, "Capability Driven Development: An Approach to Designing Digital Enterprises", Business and Information Systems Engineering, vol. 57, no. 1, pp. 15-25.

Gasparovica-Asīte, M. & Aleksejeva, L. 2019, "Classification Methodology for Bioinformatics Data Analysis", Automatic Control and Computer Sciences, vol. 53, no. 1, pp. 28-38.

Ginters, E. & Revathy, J.C. 2021, "Hidden and latent factors' influence on digital technology sustainability development", Mathematics, vol. 9, no. 21.

Philip, A.C., Ginters, E. & Basdogan, D. 2021, "Bayesian acyclic network based environmental footprint risk assessment system for oil and gas industry", International Journal of Circuits, Systems and Signal Processing, vol. 15, pp. 913-927.

Grabis, J. & Chandra, C. 2016, "Joint optimization of process design and operational policies", IEEE Engineering Management Review, vol. 44, no. 3, pp. 32-45.

Kampars, J., Zdravkovic, J., Stirna, J. & Grabis, J. 2020, "Extending organizational capabilities with Open Data to support sustainable and dynamic business ecosystems", Software and Systems Modeling, vol. 19, no. 2, pp. 371-398.

Lavendelis, E. 2016, "A cloud based knowledge structure update and machine learning framework for heterogeneous multi-agent systems", International Journal of Artificial Intelligence, vol. 14, no. 2, pp. 157-170.

Lektauers, A., Pecerska, J., Bolsakovs, V., Romanovs, A., Grabis, J. & Teilans, A. 2021, "A multi-model approach for simulation-based digital twin in resilient services", WSEAS Transactions on Systems and Control, vol. 16, pp. 133-145.

Mensah, P., Merkuryev, Y., Pecerska, J. & Longo, F. 2019, "Analysing uncertainties and their impacts on deliveries of a logging company: Simulation model to foster supply chain resilience", International Journal of Simulation and Process Modelling, vol. 14, no. 3, pp. 251-260.

Merkuryeva, G. & Bolshakov, V. 2014, "Integrated planning and scheduling built on cluster analysis and simulation optimisation", International Journal of Simulation and Process Modelling, vol. 9, no. 1-2, pp. 81-91.

Merkuryeva, G., Merkuryev, Y., Sokolov, B.V., Potryasaev, S., Zelentsov, V.A. & Lektauers, A. 2015, "Advanced river flood monitoring, modelling and forecasting", Journal of Computational Science, vol. 10, pp. 77-85.

Nikitenko, A., Lavendelis, E., Ekmanis, M. & Rumba, R. 2018, "Task Allocation Methods for Homogeneous Multi-Robot Systems: Feed Pushing Case Study", Automatic Control and Computer Sciences, vol. 52, no. 5, pp. 371-381.

Osipov, P.A., Aleksejeva, L.Y., Borisov, A.N., Chizhov, Y.A., Zmanovska, T.P. & Zabiniako, V.M. 2017, "Implementation and operation aspects of a system for detecting abnormally level of user activity", Automatic Control and Computer Sciences, vol. 51, no. 6, pp. 417-425.

Osipov, P.A., Mrochko, A.E. & Borisov, A.N. 2014, "Identification of differences of user behavior profiles and user class templates", Automatic Control and Computer Sciences, vol. 48, no. 2, pp. 65-79.

Plinere, D.S., Borisov, A.N. & Aleksejeva, L.Y. 2015, "Interaction of software agents in the problem of coordinating orders", Automatic Control and Computer Sciences, vol. 49, no. 5, pp. 268-276.

Sámano-Robles, R., Lavendelis, E. & Tovar, E. 2017, "Performance analysis of MRC receivers with adaptive modulation and coding in rayleigh fading correlated channels with imperfect CSIT", Wireless Communications and Mobile Computing, vol. 2017.

Sokolov, B.V., Zelentsov, V.A., Yusupov, R.M. & Merkuryev, Y.A. 2014, "Multiple models of information fusion processes: Quality definition and estimation", Journal of Computational Science, vol. 5, no. 3, pp. 380-386.

Stepanova, V. & Eriņš, I. 2021, "Review of Decentralized Finance Applications and Their Total Value Locked", TEM Journal, vol. 10, no. 1, pp. 327-333.

Stepanova, V. & Eriņš, I. 2021, "The Blockchain-Based Model for Professional Growth Data Processing", Journal of Advances in Information Technology, vol. 12, no. 4, pp. 319-326.

Teilans, A.A., Romanovs, A.V., Merkuryev, Y.A., Dorogovs, P.P., Kleins, A.Y. & Potryasaev, S.A. 2018, "Assessment of cyber physical system risks with domain specific modelling and simulation", SPIIRAS Proceedings, vol. 4, no. 59, pp. 115-139.

Name	Surname	ORCID	Scientific field(s)	Election term
Ludmila	Aleksejeva	0000-0003-0900-3868	Engineering and technology - Electrical engineering, electronics, information and communication technology	18.09.2022
Jurijs	Merkurjevs	0000-0001-7178-5640	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Inese	Poļaka	0000-0002-9892-7765	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Egils	Ginters	0000-0003-2394-6109	Engineering and technology - Electrical engineering, electronics, information and communication technology	31.03.2024
Jānis	Grabis	0000-0003-2196-0214	Engineering and technology - Electrical engineering, electronics, information and communication technology	05.01.2025
Arnis	Kiršners	0000-0002-1252-0623	Natural sciences - Computer science and informatics	18.11.2022
Andrejs	Romānovs	0000-0003-1645-2741	Natural sciences - Computer science and informatics	25.05.2023
Jānis	Kampars	0000-0003-0045-5593	Natural sciences - Computer science and informatics	04.11.2023
Sergejs	Paršutins	0000-0002-8689-3043	Engineering and technology - Electrical engineering, electronics, information and communication technology	07.10.2023

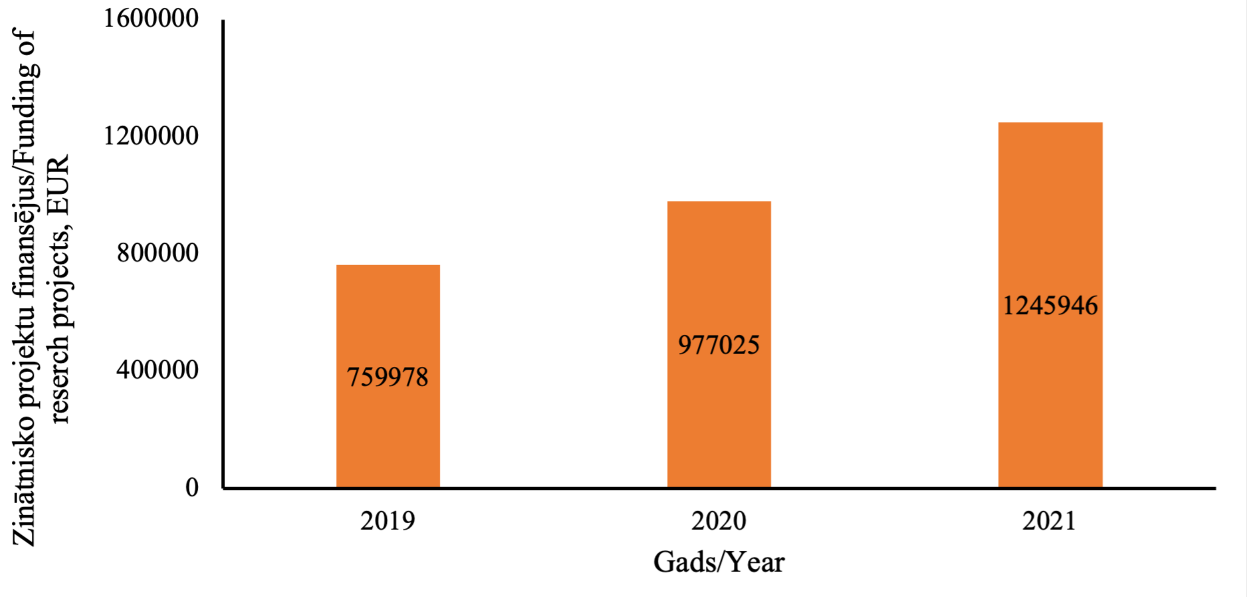
Mārīte	Kirikova	0000-0002-1678-9523	Engineering and technology - Electrical engineering, electronics, information and communication technology	23.04.2022
Jānis	Grundspeņķis	0000-0003-2526-4662	Engineering and technology - Electrical engineering, electronics, information and communication technology	23.04.2022
Jānis	Osis	0000-0003-3774-4233	Engineering and technology - Electrical engineering, electronics, information and communication technology	29.07.2022
Aleksejs	Jurenoks	0000-0003-3187-6972	Engineering and technology - Electrical engineering, electronics, information and communication technology	21.08.2022
Dmitrijs	Bļizņuks	0000-0003-4252-9220	Engineering and technology - Electrical engineering, electronics, information and communication technology	17.06.2023
Agris	Ņikitenko	0000-0002-5701-3094	Engineering and technology - Electrical engineering, electronics, information and communication technology	03.09.2023
Egons	Lavendelis	0000-0001-9912-035X	Engineering and technology - Electrical engineering, electronics, information and communication technology	06.01.2024
Marina	Uhanova	0000-0003-2994-3638	Engineering and technology - Electrical engineering, electronics, information and communication technology	31.03.2024
Katrina	Boločko	0000-0003-0729-8009	Engineering and technology - Electrical engineering, electronics, information and communication technology	02.06.2024
Zigurds	Markovičs	0000-0003-0957-7300	Natural sciences - Computer science and informatics	23.04.2022
Andrejs	Koliškins	0000-0001-7577-2898	Natural sciences - Mathematics	18.11.2022
Felikss	Sadirbajevs	0000-0001-5074-804X	Natural sciences - Mathematics	23.04.2022

3.4.4. Information on the participation of the academic staff, involved in the implementation of the doctoral study programme, in scientific projects as project managers or prime contractors/ subproject managers/ leading researchers by specifying the name of the relevant project, as well as the source and the amount of the funding. Provide information on the reporting period (if applicable).

During the reporting period, academic staff of the study program and researchers of the FCSIT have participated in the implementation of more than 110 research projects. According to RTU and FCSIT strategy regarding putting research results into practice, 63% of the projects are contractual work with the companies, which attests close connection with the industry.

Project type	Number of projects
IP 7 projects and Horizon 2020	6
COST	1
European Economic Area (EEA) and Norwegian Financial Mechanism (NFI)	1
European Agricultural Fund for Rural Development	1
ERA-NET	1
ERDF	5
EUREKA	2
Competence centers	3
Latvian Council of Science grants	6
Contract works (Customer: Commercial institutions, incl. VAS)	74
Contract work (Customer: Public authorities)	4
National Research Program (NRP)	9

Currently, the total funding of scientific projects is increasing rapidly in the study program, reaching EUR 1,245,946 in 2021.



All instructors responsible for compulsory and compulsory elective study courses have been involved in the management or implementation of scientific projects. The table provides a list of projects managed by RTU. Academic staff also participate in scientific projects carried out in cooperation organizations, e.g., assoc. Prof. Inese Poļaka participates in Horizon 2020 project "Smartphone for disease detection from exhaled air" (2016-2018) and ERDF project "Assessment of risk of big data-driven lung cancer, early development of diagnostic and forecasting method" (2018).

The implemented projects cover all research areas of the study program, including big data technologies and machine learning, autonomous robotic systems, cybersecurity, digital transformation, software engineering and sensor systems.

Project	Title	From	To	Project manager (surname, name)	Type of project
L8708	Ensuring interoperability of creation, migration and use of e-learning objects in the cloud computing infrastructure	8/27/2019	12/31/9999	Anohina-Naumeca Alla	Contracted work
L8743.1	Assessment of the offers submitted by participant of the public procurement tender No. VMD 2019/12/ELFLA “Development of a remote fire detection and monitoring system on the existing fire monitoring towers” announced by the commissioner	2/17/2020	12/31/9999	Bļizņuks Dmitrijs	Contracted work
L8796	Development of a remote fire detection and monitoring system on the existing fire monitoring towers	4/7/2020	12/31/9999	Bļizņuks Dmitrijs	Contracted work
LV9013	Development of rotation control schemes for a fundamentally new principle of levitation mixing in bioreactors, ensuring non-contact rotation of mixers in several vertical levels	11/10/2021	5/31/2022	Bļizņuks Dmitrijs	Contracted work
W4404	Finding Endometriosis using Machine Learning	1/1/2021	12/31/2024	Bļizņuks Dmitrijs	Horizon 2020
W4522	Automatic oxygen saturation control module for CPAP device, ‘O2-CPAP addon’	6/2/2021	12/31/2021	Bļizņuks Dmitrijs	Other international projects
Z18/2-0051	Fast and non-contact optical estimation of microorganisms activity	11/2/2018	12/1/2020	Bļizņuks Dmitrijs	Grants of the Latvian Council of Science (LCS)
Z18/2-0052	Skin cancer early diagnostics accuracy improvement by using neural networks	11/2/2018	12/1/2020	Bļizņuks Dmitrijs	Grants of the Latvian Council of Science

LV8992	Experimental design - to create the prototypes of an intelligent engine control module	9/23/2021	9/1/2022	Bočko Katrina	Contracted work
Z20/2-0397	Latent Impacts on Digital Technologies Sustainability Assessment and Development	12/1/2020	12/31/2021	Ginters Egils	Grants of the Latvian Council of Science
L8546	Development of the simulation model for evaluation of CyptoPolice decision-making algorithm	4/12/2018	8/31/2018	Grabis Jānis	Contracted work
L8701	Development of the analytical e-government data warehouse design framework	7/1/2019	3/31/2020	Grabis Jānis	Contracted work
L8861	Research services within the framework of the 3rd round of the European Union support measure "Practical Orientation Research"	10/5/2020	5/31/2021	Grabis Jānis	Contracted work
L8896	IWiRoM: Development of a new type of Intelligent Winter Road Maintenance information system and ERP integration solution for improving efficiency of maintenance processes	1/4/2021	7/4/2023	Grabis Jānis	Contracted work
L8926	Development of a new demand-supply management system and its service equipment for balancing electric energy at the level of transmission networks and connections	3/24/2021	12/31/2021	Grabis Jānis	Contracted work
L8931	Evaluation of Digitalization of Higher Education Institutions in Latvia	3/15/2021	12/31/9999	Grabis Jānis	Contracted work
L9010	Assessment of the company's digital maturity and detailed elaboration of three digital twin development scenarios	11/4/2021	12/31/2021	Grabis Jānis	Contracted work
L9016	Workplace planning using organizational network theory	11/12/2021	12/31/9999	Grabis Jānis	Contracted work
W4440	Advancing human performance in cybersecurity	1/1/2021	12/31/2023	Grabis Jānis	European Economic Zone (EEZ) and Norwegian Financial Mechanism (NFM)
Y4356	Advanced Resilience Technologies for Secure Services	7/1/2020	12/31/2020	Grabis Jānis	State research program (SRP)

ITKC2.01	Development of Software Adaptation Algorithms and Module Based on Context Information Extracted from Users Action Logs	09.01.2016.	12.31.2018.	Grabis Jānis	Competence Centers
ITKC2.02	Support for multi-criteria enterprise vehicle routing	10.25.2016.	04.01.2017.	Grabis Jānis	Competence Centers
F4568	Platform for a safe working environment in Covid-19 conditions	01.01.2022.	11.30.2023.	Grabis Jānis	ERDF PIP
F3548	Big Data Stream Processing Capabilities as a Service (BaSeCaaS)	01.29.2018.	03.02.2020.	Grabis Jānis	ERDF technology transfer
W1759	Capability as a service in digital enterprises (CaaS)	09.01.2013.	08.31.2016.	Grabis Jānis	7th FP projects
E1777	Future Education and Training in Computing: Now to Support Learning at Anytime Anywhere	1/10/2013	09.30.2016	Grundspeņķis Jānis	EU Lifelong learning program ERASMUS
F1927.8	Development of international cooperation and scientific capacity of Riga Technical University	1/1/2015	11.30.2015	Grundspeņķis Jānis	ERDF other
Y8089	Cyber-physical systems, ontologies and biophotonics for safe&smart city and society	11/1/2014	11/30/2017	Grundspeņķis Jānis	State research program (SRP)
Y8090.1	Applications of sensor networks and signal processing in the national economy	10/1/2014	9/30/2017	Grundspeņķis Jānis	State research program (SRP)
AIK12308	Methodological training kit in programming for training learners in institutions of general education	05.29.2020.	01.20.2022.	Jurenoks Aleksejs	Other project
LV8974	New product design - development of a motivating and developing learning aid for children and pupils	7/9/2021	6/18/2022	Jurenoks Aleksejs	Contracted work
L8660	Development of the automation solution for job input	3/1/2019	3/24/2020	Kampars Jānis	Contracted work
L8799	Resource-saving computational optimization solutions	4/1/2020	12/27/2021	Kampars Jānis	Contracted work
L8838	Contracted research on design and development of a horizontally scalable open IoT cloud platform and machine learning models	8/6/2020	4/5/2023	Kampars Jānis	Contracted work

L8895	Contracted research on the development of a smart electricity management system adapted to apartment buildings and the equipment to be integrated into them for the efficient use of the network connection and ensuring the availability of new services	1/4/2021	1/4/2023	Kampars Jānis	Contracted work
L8897	Development of big-data-driven information and communication technology security management solution (BICTSEMS)	1/4/2021	7/4/2023	Kampars Jānis	Contracted work
ITKC2.04	Scalability method for adaptive cloud computing platform corresponding to set of configurable parameters	11.01.2016.	04.04.2017.	Kampars Jānis	Competence Centers
I1933	Collaboration and Innovation for Better, Personalized and IT-Supported Teaching	1/9/2014	08.31.2017	Kirikova Mārīte	ERASMUS+
I4117	Adapting ICT solutions for active and healthy ageing in the countries of the Baltic Sea Region	1/1/2019	12/31/2019	Kirikova Mārīte	Other international projects
L9017	Mathematics advisory service	11/11/2021	11/27/2021	Koliškins Andrejs	Contracted work
Z14.0623	Vortex flows: modeling and application in energy conversion technologies, new device design, development of new technical solutions and environmental protection	4/1/2014	12/31/2017	Koliškins Andrejs	Grants of the Latvian Council of Science (LCS)
Z20/1-0076	Analysis of complex dynamical systems in fluid mechanics and heat transfer	1/1/2021	12/31/2023	Koliškins Andrejs	Grants of the Latvian Council of Science (LCS)
DAD/FCSIT	ICFSD support to implementation of internal projects	6/18/2020	6/30/2024	Lavendelis Egons	Other projects (training)
LV8966	Development of a prototype of a multimodal mobility planning and effective assessment tool	6/9/2021	1/31/2022	Lektauers Arnis	Contracted work
PL3674.1	Indirect costs (40%) of the project "Non-intrusive Human Fatigue Assessment "	11/24/2021	12/31/9999	Markovičs Zigurds	EUREKA
W3674	Non-intrusive Human Fatigue Assessment	9/1/2018	11/30/2021	Markovičs Zigurds	EUREKA
Y8109	Biometrics, biosignals and non-invasive noncontact diagnostic technologies	10/1/2014	12/31/2017	Markovičs Zigurds	State research program (SRP)

I1981	Innovation in Intelligent Management of Heritage Buildings	3/15/2016	4/29/2016	Merkurjeva Gaļina	COST
Y8090.3	Applications of sensor networks and signal processing in the national economy	10/1/2014	9/30/2017	Merkurjevs Jurijs	State research program (SRP)
W2676	Large-scale experiments and second generation simulations future ICT (FuturICT 2.0)	1/2/2017	01.31.2021	Merkurjevs Jurijs	ERA-NET
ZI-2017/2.3	Smart textile system for measuring pressure load and movement in equestrian sports	2/1/2017	12.29.2017	Merkurjevs Jurijs	Projects for science and innovation
L8970	Validation of the initial version of the operation of the technological components of the system model for the method that will evaluate performance efficiency of the IT system users and provide recommendations for optimization and improvement of usability of business processes implemented in the IT systems	6/22/2021	6/30/2021	Ņikiforova Oksana	Contracted work
L8341	Support services for the implementation of the accrual principle and improvement of the state budget payment administration processes	12/5/2016	12/31/2017	Ņikitenko Agris	Contracted work
L8305	Master Independent Contractor Agreement -Driver's fatigue detection	9/1/2016	12/31/2017	Ņikitenko Agris	Contracted work
L8432	Analysis of electricity consumption and heat data, modeling and testing services	5/26/2017	6/18/2017	Ņikitenko Agris	Contracted work
L8475	Automated solution for putting on polyethylene gloves	10/4/2017	1/31/2018	Ņikitenko Agris	Contracted work
L8511	Development of a prototype "Intelligent object recognition system"	1/15/2018	12/31/2020	Ņikitenko Agris	Contracted work
L8587.1	Research services for electric heating systems and IT systems	8/1/2018	12/31/9999	Ņikitenko Agris	Contracted work
L8738	Research on video camera data processing solutions	10/28/2019	4/30/2020	Ņikitenko Agris	Contracted work
LV8742	Development of an algorithm for optimizing the operation of sawing equipment	3/21/2019	5/31/2019	Ņikitenko Agris	Contracted work
LV8745	To conduct research and experimental design of a technological solution for a parking payment system	11/12/2019	5/11/2020	Ņikitenko Agris	Contracted work
L8749	Research on data processing models and ontology design	11/14/2019	6/30/2020	Ņikitenko Agris	Contracted work

L8750	To conduct research on card emulation solutions, encryption algorithms and data exchange models	11/14/2019	4/30/2020	Ņikitenko Agris	Contracted work
LV8806	To develop an array of parallel sawtooth optimization algorithms for “guillotine cutting” equipment	5/13/2020	1/29/2021	Ņikitenko Agris	Contracted work
L8846	Development of the models for prediction of thermodynamic system anomalies and behavior using Internet of Things data	9/1/2020	3/1/2021	Ņikitenko Agris	Contracted work
L8856	Development of personnel management analytics and data processing algorithms and development of publications	9/15/2020	11/30/2021	Ņikitenko Agris	Contracted work
LV8907	Experimental development and feasibility study for the development of industrial robots for transportation of goods in industrial warehouses	2/25/2021	2/26/2022	Ņikitenko Agris	Contracted work
LV8959	Development of a smart mailbox for the delivery of goods to private houses	5/28/2021	3/31/2022	Ņikitenko Agris	Contracted work
L8962	Analysis within the framework of WP3 STUDIES task “1.4 Studies Communication equipment and network” and task “1.6 Studies Command and Control and Interoperability”	5/25/2021	5/31/2023	Ņikitenko Agris	Contracted work
L8996	Technical advisory services on the installation and assembly of 3D printers	10/18/2021	10/27/2021	Ņikitenko Agris	Contracted work
L9001	Improvement of production quality aspects and increase of profits of poultry farms using accurate poultry farming methods based on data analysis and forecasting	10/21/2021	5/15/2022	Ņikitenko Agris	Contracted work
L8967.1	Development of a large data-driven thermodynamic process monitoring and management solution for reducing energy consumption and optimal operation of data center air cooling systems [bigTEO]	11/23/2021	7/1/2023	Ņikitenko Agris	Contracted work
W4349	CHARM, Challenging environments tolerant Smart systems for IoT and AI	6/1/2020	5/31/2023	Ņikitenko Agris	Horizon 2020
W4512.2	Innovation Fostering in Accelerator Science and Technology, I.Fast	5/1/2021	4/30/2025	Ņikitenko Agris	Horizon 2020
Y4352.3	Integration of reliable technologies for protection against Covid-19 in healthcare and high-risk areas	7/1/2020	12/31/2020	Ņikitenko Agris	State research program (SRP)

L8772	Identification of atypical activities using a semi-supervised approach in heterogeneous classroom environment	1/14/2020	2/19/2020	Paršutins Sergejs	Contracted work
L8943	Development of an Excel module for recording / calculating of visitor flow to vaccination complexes	4/29/2021	7/31/2021	Romānovs Andrejs	Contracted work
LV8965	Development of an experimental prototype of a virtual travel assistant	6/8/2021	1/31/2022	Romānovs Andrejs	Contracted work
E4396	Recommendations for Cybersecurity Curriculum for Smart Grids CC-RSG	1/10/2020	03.31.2023	Romānovs Andrejs	ERASMUS+
I2192	Information management system as an effective tool for in vitro diagnostics standardization	02.22.2016	2/5/2016	Romānovs Andrejs	7th FP projects
W4216	Innovative solutions in the planning and organization of transportation of agricultural and forestry products	1/11/2019	12.30.2022	Romānovs Andrejs	European Agriculture Fund for Development of the Countryside
ZI-2020/2.2	Development of orthopedic rehabilitation assistance vehicles and analysis of their cyberphysical models	1/1/2020	12.31.2020	Romānovs Andrejs	Project for science and innovation
L8275	Development of a set of artificial intelligence and computer vision algorithms for identification of pop-up advertisements in television broadcasts	4/5/2016	5/11/2016	Sisojevs Aleksandrs	Contracted work
L8289	C-financing for publishing of research papers in Elsevier journal Procedia Computer Science (up to 100 articles up to 8 pages each), as well as 50 printed and bound copies of the journal. All papers included in Scopus and/or Web of Science.	7/1/2016	12/31/2016	Uhanova Marina	Contracted work
eINTERASIA	ICT Transfer Concept for Adaption, Dissemination and Local Exploitation of European Research Results in Central Asia's Countries. eINTERASIA	03.01.2013.	08.31.2015.	Uhanova Marina	7th FP projects

3.4.5. Assessment of the cooperation between the teaching staff members by specifying the mechanisms used to promote the cooperation and ensure the interrelation between the study programme and study courses/ modules. Specify also the proportion of the number of the students and the teaching staff within the study programme (at the moment of the submission of the Self-Assessment Report).

Scheduling of the study courses ensures successive acquisition of knowledge; the curricula of the study courses are coordinated. Descriptions of the study courses specify the necessary preliminary knowledge and study courses to be acquired previously. Cross-referencing among the study courses is the matter of regular discussions at academic departments, which are coordinated by the Head of the study program. The experience exchange amongst the academic staff is promoted at the methodological seminars organized by FCSIT.

Study courses are mutually complementary. DOP727 “Research Methods in Computer Science and Information Technology” form the basis for further studies and the academic staff coordinate with supervisors which research methods to pay more attention to. Scientific supervisors also participate in the coordination of individual plans of students, including the selection of specialization study courses. DSP795 “Transfer of Research Results in Computer Science for Industrial Applications” in year III, based on students' existing achievements, helps steer learning outcomes to the technology transfer path. In compulsory elective study courses, students take exams in the presence of examination committee involving academic staff from several departments, which provides an opportunity to exchange views.

The current student to staff ratio is 3, which is in compliance with the average level among the leading universities around the world.

Annexes

III - Description of the Study Programme - 3.1. Indicators Describing the Study Programme		
Sample of the diploma and its supplement to be issued for completing the study programme	5.16.pielikums - Diploma paraugi.zip	5.16.pielikums - Diploma paraugi.zip
For academic study programmes - Opinion of the Council of Higher Education in accordance with Section 55, Paragraph two of the Law on Higher Education Institutions (if applicable)	A29_3.1.2_DDC0(51482)_ProvisionalTranslationofJustification250stud_eng.pdf	5.13.pielikums - AIP atzinums.edoc
Compliance of the joint study programme with the provisions of the Law on Higher Education Institutions (table) (if applicable)		
Statistics on the students in the reporting period	P05_3.1.4_DDC0(51482)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf	P05_3.1.4_DDC0(51482)_StatistikaparStud_LV_StatisticsonStudents_ENG.pdf
III - Description of the Study Programme - 3.2. The Content of Studies and Implementation Thereof		
Compliance with the study programme with the State Education Standard		
Compliance of the qualification to be acquired upon completion of the study programme with the professional standard or the requirements for professional qualification (if applicable)		
Compliance of the study programme with the specific regulatory framework applicable to the relevant field (if applicable)		
Mapping of the study courses/ modules for the achievement of the learning outcomes of the study programme	P08_3.2.1_DDC0(51482)_Mapping_eng.pdf	P08_3.2.1_DDC0(51482)_Kartejums_lv.pdf
The curriculum of the study programme (for each type and form of the implementation of the study programme)	P09_3.2.1_DDC0(51482)_Plan_EN.pdf	P09_3.2.1_DDC0(51482)_Planojums_lv.pdf
Descriptions of the study courses/ modules	A10_DDC0(51482)_StudyCoursesdescr_ENG.zip	P10_DDC0(51482)_StudijuKursuapraksti_LV.zip
Description of the organisation of the internship of the students (if applicable)		
III - Description of the Study Programme - 3.4. Teaching Staff		
Confirmation that the academic staff of the doctoral study programme includes not less than five doctors, of which at least three are experts approved by the Latvian Council of Science in the branch or sub-branch of science in which the study programme intends to award a scientific degree (if applicable)	DDC0(51482)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip	DDC0(51482)_Apliecinajums_LZPsaraksts_ConfirmationLCSlist_3.4.1_lv_eng.zip
Confirmation that the academic staff of the academic study programme complies with the requirements specified in Section 55, Paragraph one, Clause 3 of the Law on Higher Education Institutions (if applicable)	Confirmation - on compliance of the academic staff.edoc	Apliecinājums - AL 55. pants par prof. skaitu akadēmiskās programmās.edoc