VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

STUDY PROGRAMMES
IN THE FIELD OF MATHEMATICS (G100)

TECHNOMATHEMATICS
(State code: 621G16001, ISCED code: 75499)

SELF-ANALYSIS REPORT

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Vilnius, March 2014

Study Programme Profile

Title of study programme	*Technomathematics*
State code	621G16001
Kind of study programme	university studies
Study cycle	second
Study Mode (duration in years)	Full-time (continual) studies (2 years)
Volume of study programme in credits	120
Degree and/or qualification title	Master degree in mathematics
Registration date of study programme	2007

List of self-evaluation report development group

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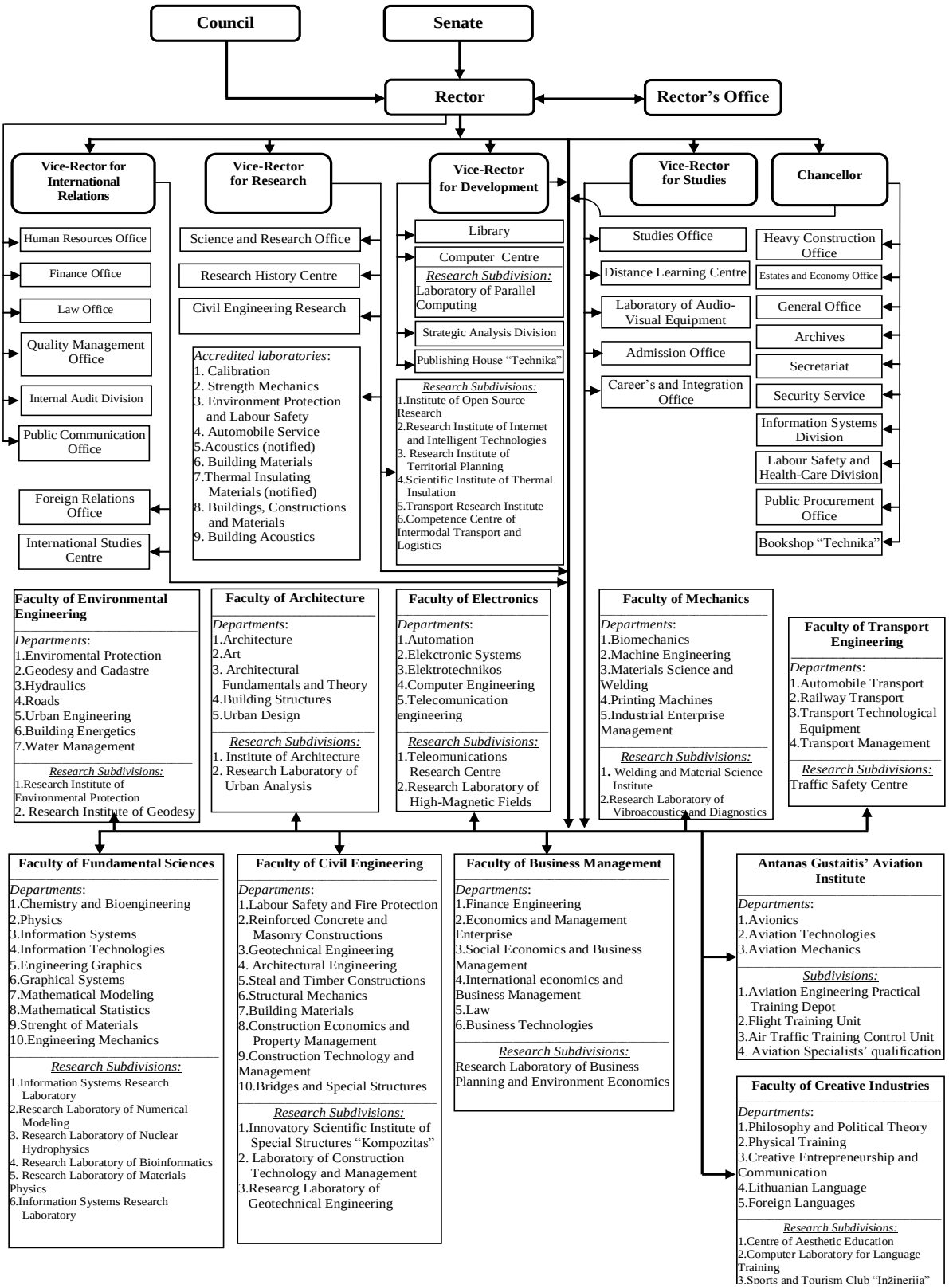
8. ANNEX

Introduction

1.1. University structure, subdivisions, their management and interrelations, the appropriateness and weaknesses of the structure

1. The university is made of faculties, departments, research and educational laboratories, research and academic institutes and centers, library, publishing house, administration and other subdivisions (Figure 1.1). The Council of university approves and changes the university structure presented by the Rector. Subdivision regulations determine the purpose and competence of the university subdivisions.
2. The main subdivision of university studies and education is department. Department independently solves the objectives of education and studies determined by university and faculty. A department has subordinate laboratories and other subdivisions. A department is supervised by the head of department. The position of the head of department may be assumed by a scientist of the study field, the competence of which corresponds to the determined requirements. The candidature of the head of the department is proposed by the department; the Dean either offers the candidature proposed by the department or proposes another candidature for the approval of the Rector. Rector either offers the candidature of the Dean proposed by the Faculty Council or another candidature for approval of the Senate.
3. A faculty or any other research institute or center exercising the rights of a faculty is the most important subdivision of study organization. The Faculty is headed by the Faculty Dean. The Dean is assisted by the Dean's Office that is comprised of the Dean, the chair of the Faculty Council, vice-deans, and heads of departments. The term of Dean and the office of the head of the department amount to five years. The Faculty Council is a collegial management body. It is elected for five years by the electoral conference. The Faculty Council approves plans for reorganization of the University structure, scientific, economical and financial actions, takes decisions with regard to studies and scientific research at the Faculty, proposes a candidate for the position of the Faculty Dean to the Rector, considers the annual operating report presented by the Dean, proposes candidates for pedagogical degrees and honorary titles to the Senate.
4. The University has collegial management bodies – the Council and the University Senate. The Council approves the vision and mission of the University; approves the strategic activity plan presented by the Rector; approves principles for selection and assessment of employees of the University; elects, appoints and dismisses the Rector; takes care of the University support. The Council controls and approves University budget and finance, as well as strategic activity (development) plan. The Senate is the collegial management body of the University. The Senate is headed by the Chair of the Senate and the Deputy Chair of the Senate. In Senate work five permanent commissions: research, studies, students, law, and ethics. Rector heads the University and is responsible for the results of the University work. The orders of Rector are mandatory for the University employees and students. Part of the Rector's functions is taken by the vice-rectors and the chancellor. The number of vice-rectors and their functions proposed by the Rector are approved by the Council. The general issues related to studies are considered by the Rector's Office which is governed by the Rector. The Rector's Office comprises of vice-rectors, deans and representatives of other subdivisions. The issues related to studies are periodically solved in the Rector's Office with the heads of the departments. Important issues can be as well discussed in the Council, the Senate and the Councils of faculties or in the university and faculty study committees. This structure and interrelations are sufficient in order to carry out study programmes properly.
5. Technomathematics study programme was registered at the Centre for Quality Assessment in Higher Education (SKVC) in 2007; it has been implemented since 2008/09/01. The programme has not been previously assessed. Technomathematics second cycle study programme was accredited until 31 December 2014 (SKVC directors order No. 1-73 of 17 August 2009).
6. Technomathematics study programme is implemented by the FFS departments of Mathematical Modelling, Theoretical Mechanics and Strength of Materials. Some of the course units are delivered by the teachers of Engineering Graphics, and Mathematical Statistics Departments.
7. A workgroup was establish to conduct self-assessment of the second cycle Technomathematics study programme and prepare the self-assessment report (approved by order of VGTU rector of 2013/09/13 No. 813). Members of the workgroup and other critical information is provided in the bottom of the second title-page.
8. Self-assessment group members' work areas and the schedule for carrying out the self-assessment activities, approved by the VGTU vice-rector for academic affair on 2013/09/13, are presented in the table in Annex 1. The report was prepared in accordance with the set schedule.



1.1. Scheme of VGTU structure

2. Programme aims and learning outcomes

2.1. Programme aims and learning outcomes

9. The aim of the programme is to train highly qualified technomathematics Masters who meet the market needs of Lithuania and the European Union, are capable of applying acquired knowledge and modern technology in the field of scientific researches and experimental development. Graduates of "Technomathematics" Master's studies acquire knowledge of applied mathematics, informatics and engineering, as well as abilities to apply it in the projects to develop and improve new technologies under different conditions and in different fields; they are able to make decisions having limited amount of information available; they can communicate with specialists of their own or related fields in different audiences; capable of generalising received results; have skills of independent education in research work. Graduates of the programme may pursue doctoral studies in Lithuania and foreign universities.
10. In order to define programme aims more accurately, we emphasize that the aim of "Technomathematics" master's study programme is to prepare a mathematics Master who:
    - Has sufficient theoretical knowledge of classical and applied mathematics for independent research work.
    - Is able to practically apply up-to-date methods of applied mathematics and algorithms, can creatively modify, summarize and apply them for solving tasks in a new or unfamiliar environment.
    - Is able to effectively apply up-to-date information technologies for solving tasks of engineering, technological and industrial systems.
    - Can analyse, interpret, evaluate the results of the research, distinctly convey them to professionals and those who do not have any special training, is interested in mathematics and regularly develops his/her skills.
11. Intended learning outcomes of the programme are formulated on the basis of the VGTU Senate Resolution No. 57-1.7 of May 29 2012 "On Description of Full-time and Part-time Study Implementation Procedures". The programme results are directly related to the implementation of the programme aims, reflect a consistent change of knowledge and understanding complexity characteristic of the second cycle studies.
12. Technomathematics Master's study programme learning outcomes:

Knowledge and its application

K1. Students acquire knowledge of information technologies project management, information visualization technology, development, testing and support of sophisticated mathematical modelling and analysis packages.
K2. Knowledge of engineering objects design systems, design technology, automated design systems.
K3. Knowledge of modern scientific research methods and application of their results in various fields of industry and services.
K4. Knowledge of up-to-date algorithms for numerical solution of differential equations, knowledge of the theory of stochastic differential equations and methods of asymptotic analysis of differential equations.
K5. Understand principles for the non-linear tasks' solutions.
K6. Master the principles of modern algorithms formation and realization, acquire knowledge of algorithms complexity analysis.
K7. Acquire knowledge for solving different physical medium's analysis problems.

Abilities to conduct research

RA1. Students acquire the skills to plan scientific research, apply packets of mathematical modelling and analysis, algorithms of information visualization technology.
RA2. Are able to develop mathematical models of physical, technical and biological objects following the basic principles of mathematical modelling methods.
RA3. Are able to analyse modelling results seeking the optimal solution by evaluating the adequacy and accuracy of the model and if needed, improving the models.
RA4. Are able to apply up-to-date methods of scientific research, master modern algorithm design and realization methods and analyse the complexity of these algorithms.

RA5. Are able to present projects, interpret achieved results, formulate and motivate the conclusions, evaluate the prepared reports and documents.

Special abilities

SP1. Students are able to abstract the information of physical, technical, biological, economic and other fields, to describe it in the mathematical language.

SP2. Are able to search, select and understand the scientific mathematical literature, and apply the latest research knowledge for solving specific scientific and practical tasks.

SP3. Are able to analyse, understand and master new mathematical methods and technologies.

Social abilities

SA1. Are able to reasonably, clearly and correctly convey scientific information orally and in writing, to find the information resources.

SA2. Are able to reason about phenomena, to understand and critically evaluate other people's ideas and results, to work with co-workers who have different education.

SA3. Are able to work independently and in a team, articulate a personal position, defend it, make suggestions and discuss ideas.

SA4. Are able to write reports, prepare, analyse, review and evaluate technical documentation.

Personal abilities

PA1. Are able to think creatively, to generate new ideas.

PA2. Are able to make decisions individually.

PA3. Are able to clearly articulate ideas, to convey mathematical information to professionals in other fields.

13. The correlation of the study programme's learning outcomes and the subjects are presented in Table 2.1.
14. The learning outcomes of the study programme fulfil the programme aims. Learning outcomes are achieved by studying programme courses, preparing individual papers and the final thesis. Details of the technomathematics programme aims and anticipated learning outcomes are available on the university's information system "Alma Informatica" on https://medeine.vgtu.lt/programos/, on the website of the Department of Mathematical Modelling http://www.techmat.vgtu.lt, on the website of the open information, consulting and guidance system (AIKOS) http://www.aikos.smm.lt/aikos/ and on the website of Lithuanian Higher Education Association for General Admission (LAMA BPO) http://www.lamabpo.lt/. Also, this information is presented in the annually organized VGTU "Open Doors" events, and on the built-in information monitors in the VGTU lobby.

2.2. Periodicity of learning outcomes' review and compliance with legislation

15. The outcomes of the study programme are continuously reviewed and updated. They are regularly discussed at the program committee with the programme executives and students. One of the last debated questions was the possibility of shortening the duration of the study programme from two to 1.5 years. The need for such talk was dictated by the trend to shorten the study period in related study programmes. The information about the meetings is available on the programme's website http://www.techmat.vgtu.lt/. The periodical review is determined by the market trends and, in part, by a constant change of legislation, which regulates the form of the study programme and requirements for programmes.
16. Social partners are members of the study programme committee, they are involved in the FFS study committee activities and the faculty council. The social partners contribute to solving evaluation/improvement issues of each functioning programme by submitting their proposals. Employers participate in the evaluation process of learning outcomes by chairing the qualification degree awarding commission. The process and results of final theses defence, employers' and students' proposals and comments are discussed at the department meetings, where the recommendations on the improvement of final theses' quality and development of study programme are adopted by consensus.
17. The second cycle technomathematics study programme corresponds with the descriptions of the Lithuanian legal acts and normative documents, the VGTU Senate resolutions regulating the study programme and the study procedure. The main documents are:

- The resolution of the Government of the Republic of Lithuania No. 535 of 4 May 2010 *On the approval of the description of the Lithuanian Qualifications Framework*;

Table 2.1. The correlation of the programme and courses' learning outcomes

Courses	Learning outcomes																					
	Knowledge and its application							Abilities to conduct research					Special abilities			Social abilities				Personal abilities		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**RA1**	**RA2**	**RA3**	**RA4**	**RA5**	**SP1**	**SP2**	**SP3**	**SA1**	**SA2**	**SA3**	**SA4**	**PA1**	**PA2**	**PA3**
Design of engineering objects		x								x		x		x	x		x	x			x	x
Asymptotic analysis methods of differential equations				x	x			x				x	x						x			
Information visualization technology	x							x					x			x	x	x	x	x	x	x
Scientific researches and innovations			x									x		x		x		x	x	x		
Management of IT projects	x	x	x			x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Calculus methods in nonlinear mechanics					x				x		x	x	x		x	x						
Stochastic mathematical models				x						x					x	x						x
Special sections of algorithm analysis						x					x			x	x	x		x		x	x	
Method of finite elements in engineering			x		x		x		x	x	x				x	x			x			x
Numerical solution methods for differential equations				x	x	x	x	x		x		x		x	x	x		x	x	x		x
Mathematical modelling of electromagnetism phenomena			x					x						x			x					x
Theory of inverse problems			x		x		x	x	x	x			x	x	x	x		x		x	x	x
Global optimization methods			x		x	x		x		x	x		x		x	x		x			x	
Basics of the development of mathematical modelling packets	x	x				x		x			x			x	x	x			x			
Final thesis 1			x						x	x				x		x			x	x		x
Final thesis 2			x						x	x				x		x			x	x		x
Final thesis 3			x						x	x				x		x			x	x		x
Final thesis			x						x	x		x	x	x	x	x	x	x	x	x		x
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**RA1**	**RA2**	**RA3**	**RA4**	**RA5**	**SP1**	**SP2**	**SP3**	**SA1**	**SA2**	**SA3**	**SA4**	**PA1**	**PA2**	**PA3**

- The order of the Minister of Education and Science of the Republic of Lithuania No V-826 of 3 June 2010 *On approval of the description of general requirements for master's study programmes*;
- The order No. V-2212 of the Minister of Education and Science of the Republic of Lithuania of 21 November 2011 "*On approval of the description of study cycles*".;
- The decree No. 57-1.9 of the VGTU Senate of 29 May 2012 "*On approval of general principles of the second cycle study programmes development*";
- The resolution No. 58-3.1 of the VGTU Senate of 26 June 2012 "*On approval of Vilnius Gediminas Technical University study regulations*";
- VGTU requirements for second cycle study programmes and general principles of their development are approved in the session by the resolution No. 57-1.9 of the VGTU Senate of 29 May 2012.

18. Compliance of the programme's learning outcomes with the study cycle is presented in Table 2.2.

Table 2.2. Compliance of the technomathematic study programme with the study cycle

	Learning outcomes for the second study cycle	**Learning outcomes of the study programme**
Knowledge and its application	The most up-to-date knowledge in the field of studies and activities, the ability to apply it to solve problems in a new or unfamiliar environment, to conduct scientific researches or to be engaged in professional artistic activities (implementation of innovations) are based on the results of fundamental or applied scientific researches (research parts of art projects).	K1. Students acquire knowledge of information technology project management, information visualization technology, development, testing and support of sophisticated mathematical modelling and analysis packages. K2. Knowledge of engineering objects design systems, design technology, automated design systems. K3 Knowledge of modern scientific research methods and the application of their results in different fields of industry and services. K4. Knowledge of modern algorithms numerical solution of differential equations, the theory of stochastic differential equations and methods of asymptotic analysis of differential equations. K5. Understand solution principles of the non-linear problems. K6. Master the principles of modern algorithms structure and realization; acquire knowledge of algorithms complexity analysis. K7. Acquire knowledge of different physical environment's analysis problem solving.
Abilities to conduct researches	Are able to analyse, synthesize and evaluate research data necessary for studies, scientific (artistic), professional activities and innovations implementation, integrate knowledge and control complex situations, make decisions in the absence of detailed and defined information, evaluate alternative solution variants, and the potential impact on the environment.	RA1. Students acquire scientific research planning skills; apply packets of mathematical modelling and analysis, algorithms of information visualization technology. RA2. Are able to develop mathematical models of physical, technical and biological objects, following the basic principles of mathematical modelling methods. RA3. Are able to analyse modelling results by looking for optimal solutions, evaluating the adequacy and accuracy of the model, and if needed, improving the models. RA4. Are able to apply modern scientific research methods, master modern algorithm

		design and realization methods and analyse the complexity of these algorithms. RA5. Are able to present projects, interpret achieved results, formulate and motivate the conclusions, evaluate the prepared reports and documents.
Special abilities	Are able to apply the acquired knowledge and on its basis develop new means (technical, methodological, informational, organisational-managerial) required for scientific researches, studies, cultural and artistic activities or for innovations implementation.	SP1. Students are able to abstract the information of physical, technical, biological, economic and other fields, describe it in the mathematical language. SP2. Are able to search, select and understand scientific mathematical literature, apply the latest research knowledge while solving specific scientific and practical tasks. SP3. Are able to analyse, understand and master new mathematical methods and technologies.
Social abilities	Are able to clearly and convincingly convey generalised information to specialists and other people by critically evaluating it. Take responsibility for quality of their own and their subordinates' activities and its evaluation in accordance with professional ethics and public spirit. Take responsibility for their own and their subordinates' activity improvement.	SA1. Are able to reasonably, clearly and correctly convey scientific information orally and in writing; find information sources. SA2. Are able to reason about phenomena, understand and critically evaluate other people's ideas and results, work with co-workers who have different education. SA3. Are able to work independently and in a team, articulate a personal position, defend it, make suggestions and discuss ideas. SA4. Are able to write reports, prepare, analyse, review and evaluate technical documentation.
Personal abilities	Are able to independently plan the learning process, independently choose development path and continue learning individually. Are able to benefit from the research (artistic activity) knowledge, have research experience, systematic and strategic thinking skills for independent professional activities and scientific researches (artistic activity). Are able to make innovative decisions by evaluating potential social and ethical consequences of the activities. Are aware of moral responsibility for their activities, and their impact on the results of the social, economic and cultural development, welfare and the environment.	PA1. Are able to think creatively, generate new ideas. PA2. Are able to make decisions on their own. PA3. Are able to clearly articulate ideas, convey mathematical information to professionals in other fields.

19. Having joined the European Union, Lithuanian specialists became involved in European and regional - scale programmes and projects for solving various applied problems. This task requires highly skilled specialists not only in the field of information technology (databases, computer network installation and maintenance), but also in such fields as mathematical modelling, numerical algorithms, development of specialized software packages. Such specialists must also have sufficient knowledge in a particular applied field (e.g. a technical subject, biotechnology) and the potential to deepen it. The basic study programme of technomathematics trains such specialists, but only the higher – cycle master's and doctoral studies can prepare fully-fledged specialists, able to solve complex mathematical modelling issues. The

technomathematics programme was developed as a complete chain of studies: bachelor‘s studies, master‘s studies and doctoral studies. Only then the studies are completed and the specialist will have acquired the knowledge and ability equal to the European level.

20. It should be noted that in Lithuania, as well as other Baltic States, mainly specialists in the field of statistics are trained while training the second-cycle specialists of mathematics and statistics, and there are fewer programmes that train technomathematics (applications of mathematics) specialists. When the specialists complete this programme, they have good employment opportunities in the fields related to the application of mathematics, computing and engineering knowledge: the high-tech sector (lasers, electronics and nanotechnology, biotechnology, information and communication technologies, telecommunications, mechatronics), the sectors of state management, business, trade, services, finances, education, health care and social security.
21. Lithuania becomes an attractive country for competitive domestic and foreign-capital manufacturing and service international companies, which focus on high-technology and science-intensive resources (Barclays, Western Union, CSC, Google, ...), to set up headquarters. This also increases the employment opportunities for those who studied in the master's programme and have a Master‘s degree in Technomathematics.
22. Technomathematics and similar master‘s programmes are implemented in many European, especially German, technical universities, e.g. Munich, Dresden, Paderborn, Chemnitz, Kaiserslautern.
23. The Government of the Republic of Lithuania approved a new classification of study fields and areas “On approval of the list of study fields and areas in higher education institutions and the list of qualification degrees“ by order No.1749 of 23 December 2009. The Minister of education and science of the Republic of Lithuania approved the list of branches of study fields “On approval of the list of branches within study fields” by the order No. V-222 of 19 February 2010. According to these documents the Technomathematics (G160) study branch is assigned to the Mathematics (G100) field of studies. Graduates who complete the Technomathematics programme are awarded a Master's degree in mathematics. No other G160 study branches of the second cycle study programme are carried out either at VGTU or other Lithuanian higher education institutions.

Table 2.3. Strengths, weaknesses and improvement actions of the study programme aims and intended learning outcomes

Strengths	Weaknesses	Improvement actions
This is the one-of-a-kind programme in Lithuanian higher education institutions, training masters on the juncture of mathematics, informatics and engineering sciences.	It is not easy to study theoretical subjects of the programme, as many graduate students work, which makes it difficult to master the material.	To provide consultations for graduate students who have received bachelor‘s education of related study fields; coordinate training schedules in such a way that would enable students to perform all tasks foreseen in the programme.
Students acquire both theoretical and practical knowledge and graduates have a realistic opportunity to proceed with doctoral studies in Lithuanian and foreign universities.	Employers do not take advantage of trained masters’ qualification (masters’ abilities intended by the programme of learning outcomes).	Collaborate with potential employers, carry out the analysis of their activities and apply the student’s acquired abilities to carry out potential employers’ tasks for the nearest 5-10 years period.

3. Structure of the programme

3.1. Study plan

24. The program is structured in accordance with the order No. V-826 of the Minister of education and science of the Republic of Lithuania of 3 June 2010 “On approval of the description of general requirements for master‘s study programme“ and by the VGTU Senate resolution No.57-1.9 of 29 May

2012 “On approval of the structure of general principles for the second cycle study programmes”. The total scope of technomathematics master’s study programme, the scope of particular subjects and their groups (including theoretical modules, course projects and final theses), final exams, students' independent and classroom work conform to the legal requirements (Table 3.1).

Table 3.1. The conformity of the technomathematics second cycle programme with legislation

Part of the programme	Anticipated in the programme	Legislation requirements
Study field subjects	70 credits	Not less than 60 credits
Subjects set by the university and the student's elective courses	18 credits	Not less than 30 credits
Final paper	39 credits	Not less than 30 credits
Volume of studied and credited subjects in the semester	4-5	Not more than 5
The number of credits in a year	60 credits	Not more than 60 credits
The volume of the whole programme	120 credits	Not more than 120 credits
The volume of independent work	76 per cent	Not less than 30 per cent.
Teachers of the study subjects must have a science degree	100 per cent	Not less than 80 per cent
Subjects of the study field must be taught by teachers in the professor‘s position	Not less than 50 per cent	Not less than 20 per cent
The fields of scientific activities of the teachers‘ who teach subjects of the field must conform to the subject they teach	100 per cent	Not less than 60 per cent

25. Technomathematics subjects of the study programme are arranged in the study plan (Table 3.2) in accordance with the principles of availability, consistency, integrity and continuity. Subjects or their topics are not to overlap. All subjects of the study field are necessary for all master graduates of the technomathematics study programme. One study subject is taught one semester. The semester consists of 15 study weeks, one week of individual-studies and a four week examination and testing session. The study volume is measured in ECTS credits (hereinafter - credits). One credit is equal to 26.67 contractual hours. The volume of one study year (i.e. two study semesters) - 60 credits, while the volume of the 2 year study programme - 120 credits. No more than 5 study subjects are studied during the semester. 4 subjects are studied in each of the first three semesters, as well as one subject of the final thesis module (Final Thesis 1, Final Thesis 2, Final Thesis 3), which is not given any classroom hours. The scope of the final thesis module subjects – 3 credits each. In the fourth semester 30 credits are given to complete and defend the final paper. One common mandatory subject for the second cycle study programme is foreseen in the first semester and set by the university – Scientific researches and innovations (6 credits). In the second semester every student can choose one subject of 5 credits. In the third semester all students choose one optional subject of 7 credits. 2 course works (projects) of 2 credits are foreseen in the first, second and the third semesters. Course papers (projects) are an integral part of the relevant study subject. The plan of the study programme in semesters is submitted in Annex 6.

26. All subjects correspond with the type and cycle of studies, they are based on the subjects in the basic studies and do not overlap with their content. Studied subjects are of a qualitatively higher problematic or innovative scientific level than the subjects of the first study cycle they are based on. The logic of technomathematics study programme structure reflects its aims. In order to form the competences required for the activities of the technomathematics master‘s programme, the programme includes mathematics, informatics, engineering and interdisciplinary study subjects. Subjects are allocated in such way that doing certain courses enables students to study other courses. Intended logical module relations and their sequence also assure a consistent transition from the classroom work to the independent students‘ work and scientific researches. Finally, the results of the study programme are achieved - the necessary knowledge, understanding, general, special, social and personal abilities are acquired.

27. Intended learning outcomes for a subject, which ensure learning outcomes of the study programme, are indicated in each module's card. The curriculum is comprehensive, topics are chosen considering up-to-date scientific and practical achievements and development trends. The topics reflect the results of scientific research carried out by the lecturers, the newest literature is employed for interpreting these results. The following study methods are employed in the study process: academic classes, workshops, individual problem-solving, laboratory works, projects and final Master's thesis. The topics of classes, practical classes and laboratory works do not overlap and are related to the newest scientific research. Having received the materials for individual work and tasks for practical wok, the Master's degree students can work individually. The programme implementation practice revealed that the methods employed are relevant, and lead to intended learning outcomes. Programme aims and intended learning outcomes meet the complexity, individuality and volatility requirements for the type of studies, study cycle and 7 qualification levels described in the Qualifications Structure of the Republic of Lithuania (Decree of the Government of the Republic of Lithuania of 4 May 2010, No. 535 On Approval of Lithuanian qualification structure description).

3.2. Requirements for students' final papers

28. General requirements for a Master's thesis and the Defence Evaluation Panel are indicated in the description of general requirements for the master's study programme (The order of the Minister of Education and science of the Republic of Lithuania No. V-826 of 3 June 2010) and in the resolution No.57-1.9 of 29 May 2012 approved by the VGTU Senate "On the approval of general principles for the structure of the second cycle study programme". These documents state that the thesis must be based on independent researches or applied researches, knowledge application, or prepared as a project, revealing the abilities corresponding to the programme aims. Requirements for final theses are presented in the publication: A.V. Rutkauskas, V. Plakys, V. Sūdžius "Master's Thesis: form, structure, process", Vilnius: Technika, 2011. They are found in the publication: A. Kaulakienė, A. Petrėtienė L. Rutkienė, R. Žukienė " Linguists' tips for students: theory and practice." Vilnius: Technika, 2010.
29. The master's thesis is an individual and designed qualification work done by the student of the second cycle studies. The defended master's thesis shows that the author is able to independently collect and systematise the knowledge, analyse the potential problems, has mastered the application of knowledge to solve practical problems and has skills to use information technology and communicate in written form, is able to properly formulate conclusions. The master's thesis reveals how the study programme can help develop the postgraduate's intellectual powers, so that they would be sufficient to solve practical problems by using generated knowledge.
30. Students start preparing the final thesis for the second cycle studies in the first semester. During the first stage (Thesis 1), postgraduates collect and process the primary, secondary, or other scientific information, and formulate the problem that has to be analysed and its relevance, research object, the aim and tasks. The plan is made for the preparation of the scientific work. At the beginning of the second stage (Thesis 2) the study methods are submitted, the basic formulations found in the work introduction are revised. In the third - research stage (Thesis 3) - calculations and experimental researches are conducted, the obtained research results are presented. Reasoned conclusions are formulated. Postgraduates are allowed to finish and present the part of their thesis module until the end of the session, i.e. until the date set in the study schedule. All the thesis preparation stages are graded.
31. The final stage of the research work (Final Thesis) includes the supplemented and revised results of all previous stages. The main aim of this stage is to use all received theoretical and practical results and prepare the designed applied section which reflects the author's abilities to present generalised conclusions and recommendations, the skills to think independently and creatively while making important decisions, intended scientific and technical development opportunities and prospects, thus, grounding the expediency of the proposed tools and research methods. The topics and the academic advisors for final theses are approved by the order of the dean of the faculty before the date indicated in the study schedule. The list of postgraduates, topics and academic advisor's names is entered into the final theses database study subsystem of the information system.

Table 3.2. Master's degree study plan for full-time studies (scope - 120 credits)

Course code	Course	Study volume per semester									
		I		II		III		IV		Total	
		h.	cred.	h.	cred.	h.	cred.	h.	cred.	h.	cred.
1. Subjects of the study field											
1.1. Mandatory subjects											
FMIGM11002	Information visualization technology	160	6							160	6
FMMAM11102	Design of engineering objects	213	8							213	8
FMMMM11102	Asymptotic analysis methods of differential equations	187	7							187	7
FMGSM11203	Management of IT projects			213	8					213	8
FMMAM11204	Calculation methods in nonlinear mechanics			213	8					213	8
FMSAM11277	Stochastic mathematical models			160	6					160	6
FMMMM11301	Specific sections of algorithms analysis					160	6			160	6
MMMM11307	Numerical solution methods of differential equations					213	8			213	8
FMTMM11302	Finite elements method in engineering					160	6			160	6
1.2. Elective courses											
FMMMM11302	Inverse calculus theory					187	7			187	7
FMMMM11303	Global optimization methods					187	7			187	7
FMMMM11304	Mathematical modelling of electromagnetism phenomena					187	7			187	7
FMTMM11303	Basics of the development of mathematical modelling packets					187	7			187	7
In total (subjects of the study field):		560	21	586	22	720	27			1866	70
2. Other courses											
2.1. Common mandatory subjects set by the university											
FMFIM11130	Scientific research and innovation	160	6							160	6
2.2. Elective courses chosen by the student											
	Free choice			134	5					134	5
Total:				134	5					134	5
3. Preparation and defence of the final thesis											
FMMMM11103[1]	Final thesis 1	80	3							80	3
FMMMM11201	Final thesis 2			80	3					80	3
FMMMM11306	Final thesis 3					80	3			80	3
FMMMM11401	Final thesis							800	30	800	3
Total study subjects:		720	27	720	27	720	27			2160	81
Total for the final thesis:		80	3	80	3	80	3	800	30	1040	39
Total in the programme:		800	30	800	30	800	30	800	30	3200	120

[1] Same subject modules are in the departments of Materials Resistance, Theoretical Mechanics, Physics

32. The evaluation procedures for the second cycle theses are regulated by the VGTU rector's order No. 576 of 25 May 2012 "On approval of the description of VGTU examination sessions and theses preparation and defence procedures for 2012 – 2013". The commission for awarding master's degrees consists of 5-7 competent specialists from the field - scientists, professional practitioners, representatives of social partners. At least one member of the commission (preferably - the chairperson) has to be from a different scientific or academic institution, which did not participate in implementation of the current programme. The chairperson of the commission is to hold a degree and (or) a scientific title. One member of the commission is to be the academic advisor of the final thesis. The master's final thesis is applied to the same intellectual property rights and (or) the protection of commercial secrets as published scientific work. The timetable of the theses defence, the place and time, the members and chairman of the commission are announced on website of the department of Mathematical Modelling http://www.mmk.fm.vgtu.lt/ not later than 10 days before the beginning of the final theses defence. Postgraduates fill in annotations in English and Lithuanian in the theses subsystem in the University Information System (UIS) not later than one week before the beginning of the final theses defence. Theses annotations are printed from UIS and attached to the thesis. Not later than one week before the thesis defence date, when the author receives the written consent of the consultant for the Lithuanian language, the supervisor's and other consultants' positive feedback in writing, he signs the declaration of integrity, certifying that the material of the thesis is not plagiarized, attaches it to the thesis and takes it to the department.
33. When the theses are submitted for the final defence, the lecturers of the department of Mathematical Modelling and the members of the degree awarding commission are appointed as their reviewers. The final thesis is defended in a public session. The final decision on the thesis evaluation is made by the degree awarding commission members considering the quality of the thesis, its defence and the postgraduate's answers to the questions asked by the degree awarding commission members. The theses' assessment procedures and evaluation criteria are appropriate for objective assessment of postgraduates' achievements. Requirements for final theses as well as the necessary forms of documents for the preparation of all final theses are available on the website of the department http://www.mmk.fm.vgtu.lt/studijos/informacija-baigiamuju-darbu-rengimui/. The list of theses for 2009-2010, 2010-2011, 2011-12 and 2012-13 is presented in Annex 6.
34. In order to improve the programme structure, business (the state) and scientific cooperation is necessary. For example, the faculty together with other VGTU programmes should begin analysing selected fields, identifying problems and suggesting cooperation with selected business entities and government bodies to solve their problems. The technomathematics programme should look for stakeholders, who would allow analysing their activities, their processes and submit proposals for their business optimisation. This could be an example of the activities which students would learn and apply later in their life.
35. It would be possible to improve or develop the existing workshop practice. Such workshops should be run all over the university to exchange experience within their departments, to strengthen cooperation in a solving problems. It would be appropriate to invite potential employers to such workshops.

Table 3.4 Programme structure's strengths, weaknesses and improvement actions

Strengths	Weaknesses	Improvement actions
The programme structure meets the legal requirements, the course units are taught in a logical and consistent manner; the content of the study programme and methods are related to the intended learning outcomes.	There are no practical studies, which could provide students with skills in modern methods of applied mathematics and practical algorithm application.	Organize practical studies that could be linked to the annual international conference "Mathematical Modelling and Analysis".
		Get students involved in the scientific seminar work in the Department of Mathematical Modelling more actively. Invite representatives of employers to the seminars. They should be useful as an example for the participants in discovering value-added solutions, how they were found and resolved.

4. The Staff

4.1. The list of teachers

36. The list of the academic delivering classes in the second cycle technomathematics study programme, their academic titles and degrees, subjects taught in the technomathematics study programme, teaching and practical experience, fields of scientific interests is provided in Annex 3; descriptions of their scientific and pedagogical activities (CV) – in Annex 4.
37. The programme is implemented by the Department of Mathematical Modelling in collaboration with highly skilled professionals from other VGTU Departments - Strength of Materials, Engineering Mechanics, Engineering Graphics, Graphics Systems and Mathematical Statistics.

4.2. Teachers' participation in scientific research and projects

38. Over the past 5 years the teachers of the technomathematics second cycle study programme have participated in a number of Lithuanian and international research projects. In 2008-2013 9 teachers of the programme participated in 10 research projects. The department of Mathematical Modelling carries out (has carried out) the following projects:
    - The European Research, Development and Co-operation Programme "Eureka" project E! 6799 POWEROPT "The mathematical modelling and optimization of power cables to improve their design methods". The terms of the project - 2012-2015, the head of the part of the project for VGTU is prof. dr. habil. Raimondas Čiegis, the researchers: assoc. prof. dr. Vadimas Starikovičius, assoc. prof. dr. Mečislavas Meilūnas. www.poweropt.vgtu.lt.
    - The European Research, Development and Co-operation Programme "Eureka" project E! 3691 OPTCABLES "The optimization of electrical fuse and wiring layout in the cable bundles". The performance period was 2006-2009, the head of the part of the project for VGTU is prof. dr. habil. Raimondas Čiegis, the researchers: assoc.prof. dr. Vadimas Starikovičius, assoc. prof. dr. Mečislavas Meilūnas. http://www.eurekanetwork.org/project/-/id/3691.
    - High-tech development programme B-03/2007-2009 GRIDGLOBOPT "Global optimisation of complex systems using high-performance computing and GRID technologies". The head of the project is prof. dr. habil. Raimondas Čiegis, the head of the part of the project for VGTU is prof. dr. habil. is Rimantas Belevičius, the researchers: assoc.prof. dr.Vadimas Starikovičius, assoc.prof. dr.Mečislavas Meilūnas, dr. E. Filatovas. www.gridglobopt.vgtu.lt.
39. The teachers from the second cycle technomathematics study programme also participated in the following projects:

    - Assoc.prof. dr.Vadimas Starikovičius participated in the programme of the Ministry of the Education and Science of the Republic of Lithuania"The network of parallel and distributed computing and e-services" (LitGrid) (Head - prof. dr. A.Juozapavičius, VU).
    - In 2008-2010 assoc. prof. dr. Vadimas Starikovičius participated in the project BalticGrid-II which was funded from the programme FP7 "Research Infrastructures: e-Science Grid infrastructures" (INFRA-2007-1.2.3).
    - In 2010-2012 prof. dr. Aleksandras Krylovas participated in the projects:"Updating bachelor's study programmes at Mykolas Romeris university", " The update of the business informatics study programme", "Networked mathematics studies: a methodological aid".
    - In 2006-2008 prof. dr habil. Rimantas Belevičius was the head of the part of the project for VGTU of the Baltic-Taiwan programme "The identification of the advanced composite material properties".
    - In 2008-2009 assoc. prof. dr. Eugeniuš Stupak and assoc. prof. dr. M. Šukšta participated in Ignalina AE, LEI project "Modelling and analysis of Ignalina Unit A2 101/2 building seismic impact". The project head- prof. dr. habil.Rimantas Kačianauskas.
    - In 2012-2015 prof. habil. dr. R. Kačianauskas participates in FP-7 project [NMP.2011.4.0-5] INNVIN ''Innovative materials solutions for Transport, Energy and Biomedical sectors by

strengthening integration and enhancing research dynamics of KMM-VIN“. The project coordinator: The European Virtual Institute on Knowledge-based Multifunctional Materials (KMM-VIN), Belgium.

- In 2007-2010 prof. dr. habil. R. Kačianauskas was the head of the project “IAE short-lived solid radioactive waste storage structures and seismic calculations vadovas. The customer: Joint stock company “Pramprojektas“ and Joint stock company “NUKEM“.

40. Teachers who teach in the technomathematics programme constantly publish their scientific articles, prepare textbooks and other study books and publish literature on various kinds of research and studies. Over the period 2008-2013 the programme teachers published 226 scientific articles (75 are registered in the ISI Web of Science list), delivered 48 reports at national and international conferences, prepared 39 study publications (including 4 books and 22 methodological aids). The average number of publications per staff member is 4.8 publications per year. The most important publications are available in the description of the teachers‘ activities, Annex 4.

4.3. Teacher - student ratio in the study programme

41. The teacher – student ratio in the technomatematics study programme is presented in table 4.1.

Table 4.1. Teacher - student ratio in the study programme

Year	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
The total number of teachers	**8**	**13**	**13**	**13**	**13**
professors	4	6	6	6	6
Associate professors	4	7	7	7	6
Lecturers	0	0	0	0	1
The total number of students	**23**	**30**	**18**	**14**	**13**
The teacher – student ratio	**0,35**	**0,43**	**0,72**	**0,93**	**1,0**
Professors/students	0,17	0,2	0,33	0,43	0,46
Associate professors/students	0,17	0,23	0,38	0,5	0,46
Lecturers/students	0	0	0	0	0,08

42. It is necessary to emphasize that the teachers in the technomathematics programme also teach general and special courses in other VGTU study programmes.

4.4. Staff members and turnover

43. The distribution of the teachers who teach in the technomatematics study programme by the position and age in 2012/2013 is given in table 4.2.

Table 4.2. Staff members by position and age in 2012/13 academic year

Position	Age group, years					Total	Total, %
	<30	31-40	41–50	51–60	>60		
Professor	0	0	1	4	1	6	**42,9**
Associate professor	0	3	1	2	1	7	**50**
Lecturer	1	0	0	0	0	1	**7,1**
Total:	**1**	**3**	**2**	**6**	**2**	**14**	**100**
Total, %:	**7,1**	**21,4**	**14,3**	**42,9**	**14,3**	**100**	**100**

44. In 2008-2013 the constant growth of qualified teachers was observed. Assoc. prof. A. Krylovas and assoc. prof. J. Kleiza performed the habilitation procedure and started working as professors. The department of Mathematical Modelling, which coordinates the programme, had 5 PhD students.

45. The average age of the teachers in technomathematics programme in 2012/2013 was 51.3 (57.2 - for professors, 49.4 - associate professors, 29 – for lecturers).

46. The teachers‘ turnover is low. During the period of the programme implementation the teacher of IT project management module changed: assoc. prof. L.Vasiliauskienė who worked from 2008 to 2011 was replaced by lect. E. Filatov who delivered lectures in 2011/2012 and 2012/2013. Since 2013 assoc. prof. E. Stupak has delivered classes on calculus methods in nonlinear mechanics instead of prof. R. Kačianauskas. Since 2013 prof. R. Kliukas has delivered the module of engineering objects design instead of assoc. prof. M. Šukšta.

4.5. Teachers' participation in academic exchange programmes

47. Teachers, who teach in the programme, are actively involved in scientific conferences, a wide range of internships, academic exchange programmes. Visits of outgoing teachers of the technomathematics second cycle study programme are as follows:
48. Assoc. prof. dr. Vadimas Starikovičius had internships at ITWM Fraunhofer Institute in Kaiserslautern, Germany on April – June 2009, on April – May 2010, on April 2013; on April – May 2012 he was in Bologna, Italy under the HPC-Europe2 programme.
49. Prof. habil. dr. Raimondas Čiegis went to Munich, Germany, the Bundeswehr Technical University (September 1 - 5, 2008, Dec. 8 - 12, 2009) and the University of Latvia (December 18 - 20 2008, December 16 -18 2009) about Eureka project OptCable issues; also went to ITWM Institute in Kaiserslautern, Germany about GridGlobOpt project design or other research issues (September 21 - 26 2008, December 7-11 2009, February 15-25, 2010, February 27 - March 11 2011); went to the WIAS Institute in Berlin, Germany to carry out a research (October 13 - November 7 2008, November 1- 27 2009, November 1- 18 2010, November 28 - December 9 2011, 26 November – 7 December 2012), delivered lectures or conducted a research under Erasmus programme at Paris university (November 23 – 28 2008, June 26 – 30 2011), at ITWM institute in Kaiserslautern, Germany (March 9 – 20 2009 , November 1 – 11 2011 , October 29 - November 3 2012), at the university of Zaragoza in Spain (April 19 – 25 2009 , March 21-26 2010, May 1 – 7 2011, April 23 – 29 2012, April 21 - 27 2013), at WIAS institute Berlin, Germany (June 18 – 22 2013 m.), had a research visit to Copenhagen about DTU COST STSM project issues on May 16-22 2010 , had a research visit at the university of Latvia in Riga (December 15-17, December 20-22 2011), visited the Bundeswehr University in Munich, Germany about Eureka project Poweropt issues on July 1-5 2013.
50. Assoc. prof. dr. Igoris Belovas made reports on the project HPC-Europa2 topics "Parallel computing in estimation of parameters of alpha-stable distribution" and "Limit theorems for the Riemann zeta-function and Dirichlet L-functions: computer simulation" in Italy 2010, and on the project DAAD topic „Mixed-stable models for analysing high-frequency financial data" at the Karlsruhe Institute of Technology in Germany in 2010.
51. During the 5-year term the university does not provide the teachers of the department any possibilities to attend a refresher course in other scientific or research institutions. Currently, teachers improve their qualification on their own initiative, so only a few teachers attended a refresher course. However, we believe that this is a very important aspect of the training and we are working on the possibility of providing teachers trips using internal department reserves and partially covering the cost of trips from the faculty resources.

4.6. The ways of teachers' qualifications (pedagogical, scientific, practical) improvement

52. Teachers' qualifications in the technomathematics study programme meet the requirements for the university master's study programmes (The VGTU Senate Resolution No. 57 – 1.9 of 29 May 2012 "On approval of general principles for the second cycle study formation". All (100%) teachers who teach courses have an academic degree and the fields of the subjects correspond with the fields of their ongoing research activities (Table 3.1). The staff consists of 14 teachers, 43 per cent of them work in the department of Mathematical Modelling, 57 per cent - in other VGTU departments. Teachers are appointed to a position in accordance with public procedures established by the Statute of the University for the 5-year term. The competition and certification commission appointed by VGTU Senate determine the staff conformity with the qualification requirements, validate them and organize competitions for the

position, with the assistance of competition and certification committees of faculties and the personnel directorate. The teachers sign fixed-term employment contracts for a semester or one academic year.

53. Teachers improve their professional skills by participating in scientific conferences, projects, conducting research, preparing scientific papers, participating in academic exchange programmes. The programme teachers have 5 - 39 years of teaching experience and 5 - 38 years of practical experience. They are active researchers and professionals in their field. In 2009-2010 professor R. Čiegis was the chairman of the Research Council of Lithuania for the assessment of activities of scientific institutes in the field of informatics, in 2010-2013 he was the representative of Lithuania in the Information and Communications Committee of the European Commission on the programme FP7, a member of the international accreditation commission of the Latvian Centre for Quality Assessment in Mathematics, Statistics and Physics study programmes (2012) and the Chairman of the International Accreditation commission of informatics study programmes (2012), the external evaluation expert of the project Promoting Internationality of Biomedical and Physical Sciences study programmes at Vytautas Magnus University (VP1-2.2-MES-07-K-02-055) (2013), scientific advisor for the department of Flow and Material Simulation at ITWM institute in Kaiserslautern, Germany, http://www.itwm.fraunhofer.de/en/departments/flow-and-material-simulation/employees.html).
54. The teachers of the programme are active members of editorial boards and editors of international mathematical journals included in the list of ISI Web of Science. Prof. R. Čiegis is the editor-in-chief of the journal "Mathematical modelling and analysis", a member of the editorial boards of the journals "Lithuanian Mathematical Journal" and "Computational methods in applied mathematics" (http://www.degruyter.com/view/j/cmam). Prof. A. Krylovas is the executive editor (executive secretary) of the journal "Mathematical Modelling and Analysis", assoc. prof. M. Meilūnas, assoc. prof. V. Starikovičius are the members of the editorial board of the journal. Prof. R. Kačianauskas is a member of the editorial committee of "Journal of Civil Engineering and Management", Vilnius Gediminas Technical Universitety http://www.tandfonline.com/loi/tcem20/ and a member of the editorial committee of the journal ":Mechanika", Kaunas University of Technology http://www.mechanika.ktu.lt/index.php/Mech/ . Prof. R.Kačianauskas is a member of the advisory board of the journal "Mechanics and Control", Cracow University of Technology Sciences http://www.mechanics.agh.edu.pl/index.php/en/info/office/).
55. Prof. R. Čiegis was elected a foreign member of the Latvian academy of sciences. Since 2008 prof. R. Kačianauskas is an expert-member of the technical department of the Lithuanian academy of sciences. Since 2011 – a member of the Lithuanian academy of sciences.
56. The efforts of the Department of Mathematical Modelling led to organising of international mathematical modelling and analysis conferences in Lithuania, Latvia and Estonia since 1996. Prof. R. Čiegis is the constant member of the conference programme committee. Prof. R. Čiegis is a member of the programme committee of the conference "Parallel Processing and Applied Mathematics" held in the Republic of Poland and the organiser of the Mini-symposia and the organiser of the Mini-symposium in a conference held in the Republic of Finland "State-of-the-Art in Scientific and Parallel Computing". Prof. A. Krylovas was a member of the programme committees of the scientific conferences at Mykolas Romeris university in Vilnius: "International conference on social technologies '10, (2010.), "International academic conference social technologies '11: ICT for social transformations" (2011), "International academic conference social technologies '12: development of social technologies in the complex world" (2012). Prof. A. Krylovas is the chairperson of the organising committee at the conference of Lithuanian mathematicians, which is to be held in 2014.
57. All teachers of the technomathematics programme are participants of the constant scientific workshop organized by the department of Mathematical Modelling.

Table 4.3. Strengths, weaknesses and improvement actions of the study programme staff

Strengths	Weaknesses	Improvement actions
Competent, very experienced teachers in pedagogical and practical activities, actively involved in applied research and project activities.	Not all teachers have a good knowledge of English, preventing the programme's internationalization.	To encourage teachers to improve their English by participating in international events and attending English courses regularly organized by VGTU.

Teachers' high qualification maintained by the departments that implement the programme and by individual efforts; young scientists' participation in the programme implementation.	Lack of publications in high impact factor foreign journals.	The presentation of works by visiting teachers and the teachers of the department in the constant scientific workshop arranged by the Department of Mathematical Modelling.
	Limited opportunities for teachers to go for internships and qualification improvement courses.	

5. Material Resources

5.1. Facilities

58. In order to achieve the technomathematics learning outcomes it is necessary to pay constant attention to the rational use of material resources, the increase of the library stock, the acquisition of software, furniture, computers and other material resources. Material resources are increased by the allocations both from the EU Structural Funds and the university's own funds. VGTU FFS facilities are used for implementing technomathematics study programme. Lectures for students take place in the classrooms of Saulėtekis building. Theoretical lectures and practical studies usually take place in SRL-I-401, SRL-I-217, SRL-I-324, SRL-I-325, SRL-I-423, SRK-II-203, SRK-II-204, SRK-II-612 classrooms. There are from 20 to 68 seats in all above – mentioned classrooms. The studies of general university subjects take place in the classroom SRA-II-10 where there are 235 seats. Each classroom is equipped with a computer and a projector. 20 to 30 students can have classes in 3 computer classrooms at the faculty SRL-I-417, SRL-I-418 (28 seats each) and SRL-I-427 (32 seats) for conducting laboratory works. Computer classrooms provide connection for laptops. SolidWorks (SRL-I-427) and ANSYS (SRL-I-324, SRL-I-325) programmes are used for virtual experiments and calculations as well as AutoCad and STAAD computer programmes (SRK-II-612). Computer classrooms have legal Microsoft software (the university belongs to Microsoft academic alliance) and legal mathematical packages: Maple (25 licences), Matlab (25 licences), Matcad (25 licences), Mathematica (2 licences), Maxima (open source software).
59. The faculty has 2 training laboratories: one for mechanical tests (10 test stands and 30 seats) and the other for fatigue tests (4 test stands). These computer classrooms and laboratories are sufficient for laboratory works foreseen in the study programmes.
60. The students of technomathematics programme can conduct engineering experiments in the scientific laboratories of the faculty: in the mechanical strength laboratory, numerical modelling laboratory and the university parallel computing laboratory. The parallel computing laboratory owns the cluster of personal computers VILKAS which consists of two types of nodes: 15 nodes with Intel® Core™2 Quad Q6600 @ 2.4 GHz processors (4 cores) and 9 nodes with Intel® Core™ i7-860 @ 2.80 GHz processors (4 cores), connected to the local Gigabit Ethernet network. The cluster enables the students to use such libraries (programmes) for the programme development and visualization: FORTRAN, C++/C, BOOST, CUDA, FFTW, GSL, HDF5, ICTCE, Intel Math Kernel, GVID, ECLIPSE, Netbeans, MPI, OpenMP. The laboratory also owns several EGEE certified grid clusters which are fully integrated into the European grid infrastructure (EGI). Modern technologies "Clouds" are studied and tested.
61. The university is equipped with optical 1Gbps backbone computer network. The same network throughput is maintained as far as the computer classrooms at the Faculty of Fundamental Sciences and students' dormitories in Saulėtekis Avenue. The wireless computer network EDUROAM (educational roaming) is available in all buildings of the university and accessible to all university students who have laptops or smart phones. EDUROAM is the European roaming service for academic institutions. The university is equipped with the unanimous student authorization system, which allows connecting to the e-mail, EDUROAM network and computers in computer classrooms using the same name and password.
62. Students can use 10 computers in the reading room of the faculty and 10 servers. All available computers are sufficient to complete assignments foreseen in the study programme. All premises assigned for studies conform to the requirements for work safety and hygiene standards. Postgraduates with physical disabilities can study in all VGTU study programmes. There is a special parking space on the university's parking lot for cars of physically disabled students, as well as special ramps and comfortable lifts.

5.2. Methodological resources

63. The VGTU library is one of the most up-to-date libraries among Lithuanian higher education institutions. There are 75 workplaces in the common reading room of the library, one of them is computerized. The Internet reading room provides 32 workplaces and 12 of them are computerized. 52 workplaces are available in the researchers' reading room and seven of them are computerized. The reading room stores research papers of VGTU and other higher education institutions, periodicals, encyclopaedias, reference books, dictionaries, masters' papers, doctoral theses. The FFS reading room is equipped with 17 workplaces and nine of them are computerized. The library stores methodological literature of natural sciences, software descriptions, information technology books.
64. The literature that is necessary for VGTU students' studies can be accessed at VGTU central library (Saulėtekis Avenue 14) and the reading rooms of faculties. The number of titles at VGTU central library exceeds 0.5 million. Methodologically the technomathematics master's study programme is based on the publications available at the VGTU library. Those departments that carry out the programme have textbooks and teaching tools on different topics (engineering mathematics, optimization, differential equations, numerical methods, parallel calculations). They are available in Lithuanian and foreign languages. This literature is also successfully employed in the study process. The library and reading room provide an online access to international and local databases full of texts. Some methodological training aids are still lacking. To offset this, summaries of study courses which are placed on the technomathematics programme website www.techmat.vgtu.lt/konspektaiM.html and Moodle environment http://moodle.vgtu.lt/ are provided. Summaries of course lectures and the visual material are prepared and regularly updated. Students can temporarily (for a semester or a shorter period) borrow textbooks or other literature from the university library. If the library has only one copy of the publication, students can read it in the reading room. The reading room of the VGTU central library works 24/7. The electronic training aids of the VGTU library are available online at http://biblioteka.vgtu.lt.
65. Postgraduates who have chosen the technomathematics study programme have an opportunity to use the online access to 29 subscribed databases of different science fields and themes such as EBSCO Publishing, Oxford Reference, Springer LINK, Taylor and Francis; databases of open access (PhysNet, ScienceResearch.com); databases of limited access (IET Digital Library, Maney Publishing Materials Science & Engineering Collection). The whole list of available databases is provided on the university library website: http://biblioteka.vgtu.lt/el--istekliai/duomenu-bazes-/. Unfortunately, not all the students take advantage of the access to scientific databases.
66. On top of the resources provided by the VGTU library, students have an opportunity to use the resources of the National library of Lithuania http://www.lnb.lt/, the premises, computers and methodological resources of open access at the National Scientific Information and Communication Centre (SCIC) near the Saulėtekis building, http://www.mkic.mb.vu.lt/. SCIC is one of the most modern and largest libraries in the Baltic countries, which is open 24/7.
67. All the facilities are constantly updated. The classrooms are maintained, computers and software are purchased. The VGTU library regularly renews its publications. Every year the library staff survey the departments and draw up a list of required books. The department of Mathematical Modelling coordinates the technomathematics study programme and every year buys new books from the faculty's and other funds. The university students can read electronic texts of the publications prepared by VGTU teachers and published by the university publishing house "Technika" on a special website of the library http://www.ebooks.vgtu.lt/bookshelf. Students can access it from the VGTU local network or the network in hostels. The students, who want to get acquainted with the research papers, conference proceedings, PhD theses, their summaries and study books, can use the VGTU repository http://dspace.vgtu.lt/?locale=en. The VGTU library subscribes various databases of scientific publications. The teachers who are involved in the programme prepare and update their summaries, write training aids and textbooks.

Table 5.1. Strengths, weaknesses and improvement actions of the study programme facilities

Strengths	Weaknesses	Improvement actions
The unique laboratory of parallel computing, equipped with the latest computing hardware and modern	Students insufficiently use the resources of the library and subscribed databases (especially	The constant updating of lectures' summaries and visual material, acquisition of new books,

software	while preparing their final theses).	database training for students.
The summaries of lectures prepared by the teachers are constantly updated, the work of the library and the reading rooms is well organised: the flexible lending system, long working hours of the libraries.		

6. Study process and its assessment

6.1. Student selection

68. The admission to postgraduate studies is organized by the university‘s Admission and Information Centre (SPIC). There are no entrance examinations for the technomathematics master‘s study programme. Admission requirements are based on the general university principles (VGTU Senate Resolution No. 57-1.11 of 29 May 2012 “On Approval of Description of Procedures for Graduate Student’s Admission to the Second Cycle Studies”. Those who want to study in the second-cycle programme have to complete the first-cycle university studies of the same or related study field and have the minimum knowledge required for the study programme. If they lack up to 10 credits in general study subjects, it is allowed to pass those examinations until the end of the first term of master’s studies. The admission criteria for the master‘s studies is the weighted average of basic studies. Candidates with the highest scores are admitted to the planned number of places. The graduates of the first-cycle mathematics, statistics, physics, chemistry, informatics study programmes, as well as other study fields who completed the course of mathematics (e.g. mathematical analysis, algebra, geometry, mathematical logic and/or discrete mathematics, etc.) – 18 credits, information technology – 12 credits, special programme subjects (e.g. differential equations, mathematical modelling, mathematical physics, numerical methods, probability theory, mathematical statistics, algorithms theory, etc.) – 18 credits are admitted to the technomathematics study programme. All the issues, not foreseen in the admission requirements are to be solved by the VGTU admission commission. The current VGTU order is reasonable as it provides a wide range of opportunities for those who want to study for a master‘s degree. The statistic data of the admission to the technomathematics study programme is provided in Table 6.1.

Table 6.1. Competitive scores of the students admitted to the study programme

Admission and Selection		2009	2010	2011	2012	2013
Wished to study		41	22	25	20	22
Students who indicated this programme as priority choice		7	6	6	8	8
Number of students admitted		14	11	7	9	6
Competitive scores of the admitted students	The highest score	13,88	12,12	12,4	12,42	12,36
	The lowest score	8,52	7,12	9,07	9,35	8,91
	The score average	9,87	9,73	11,06	10,64	10,15
The threshold score	Sf place	8,52	7,12	9,07	9,52	8,81
	Nsf place	N/A	N/A	N/A	N/A	N/A

69. The number of the applicants and the entrants to study differs. Mainly those whose priority choice was to study in the technomathematics programme were admitted. The average of the entrants’ competitive scores varies about 10,29 of the score. In 2009 and 2010 there were more admitted students, even though their score averages were lower when compared with the score averages of those who entered in subsequent years. The number of admitted students depends on state-funded places assigned for the study programme by the university, as people enter only into state-funded places. It is necessary to notice that all state-funded places assigned for the technomathematics study programme are filled to capacity. This year the number of state-funded places decreased nationwide.

6.2. Study process

69. The ratio of students who successfully completed the programme and students admitted to the programme is provided in Table 6.2.

Table 6.2 The ratio of students who finished the programme successfully to the entrants to study the programme

Year of admission	2008	2009	2010	2011
Year of graduation	2010	2011	2012	2013
Number of students admitted	23	14	11	7
Number of graduates	16	5	4	4
Ratio	**0,7**	**0,36**	**0,36**	**0,57**

70. In 2011 and 2012 the ratio of graduates and admitted students decreased. This probably happened due to the low averages of competitive scores among the entrants in 2009 and 2010. The reason why a high percentage of students fail to finish the programme is that almost all postgraduates work and do not have enough time or motivation to study and complete studies successfully. In order to increase students' motivation to study in the technomathematics study programme, the Mathematical Modelling Department teachers prepared the study of opportunities of the technomathematics study programme together with German (Dresden), Estonian (Tallinn technological and Tartu) and Latvian (Latvian) universities. http://www.techmat.vgtu.lt/skelb_files/JM_GalimybiuStudija.pdf. The plans are to get involved in the activities of ECMI (European Consortium for Mathematics in Industry). One of the main aims of the organisation is the development and implementation of the second-cycle study programmes oriented towards solving industrial problems using mathematical methods. It gives the best students opportunities to meet ECMI requirements and be awarded with an ECMI certificate.
71. An appointed person at the department makes the timetables of lectures, practical studies and laboratory works, which are then approved by the dean of the Faculty of Fundamental Sciences and the academic affairs office. The approved study timetables are published on the VGTU website https://medeine.vgtu.lt/paskaitos/paskaitos.jsp. The timetables of the examination session are also published there. The group monitors make timetables of examinations following the description of the order on organizing the session, coordinate them with the students of the group and the teachers of the subjects. Before the beginning of the session students must complete all the assignments foreseen in the study modules which can be provided individually or for groups. They are assessed in accordance with the formula of cumulative assessment indicated in the subject module card. Students can accumulate up to 50 % of the final mark during the semester. Submitting their coursework, projects and complex projects students sign declarations of integrity, which confirm that the work has not been plagiarised. In case of cheating, the dean of the faculty makes a decision on student's further studies.
72. The students of the technomathematics study programme are encouraged to actively participate in the research activities: go to the seminars workshops by the department of Mathematical modelling, participate in the annual VGTU conference "Science – the future of Lithuania". Every second-year postgraduate is to prepare and deliver a report on the topic of their final thesis in the conference. Students' participation in seminars and conferences encourages them to study responsibly and work purposefully, allows them to get acquainted with the teachers' researches, develops their ability to present their results, understand and get acquainted with the newest research achievements. All this helps the students to prepare the master's final thesis and publically defend it.

6.3. Student support

73. The chairperson and members of the technomathematics study programme committee and the academic advisors for the final theses provide constant consultations to students. Students have an opportunity to get consultations from the study programme lecturers. Postgraduates can seek consultations from the teachers who teach individual subjects in the programme. Each teacher allocates consulting hours for additional consultations and makes a consultation schedule for each semester. The programme teachers and academic advisors for the final theses communicate with the students and help them in their studies not only during the consulting hours at the department, but also by communicating with them by

electronic means, such as Skype or via the social networking site Facebook https://www.facebook.com/pages/Technomatematika/174310625932263/. Important information is also published on the study programme website http://www.techmat.vgtu.lt/.

74. VGTU has an Integration and Career office. It is a coordination unit for training and retraining, continuous studies, graduates' vocational guidance, career growth monitoring and assistance in employment, communication between the university and external institutions. The main aim of the office is the cooperation between the university, enterprises and management institutions in consulting on expert work, participation in programmes, professional training, retraining, students' guidance and graduates' employment issues. The Students' representation office take care of students issues, provides them with all necessary information and support.
75. The employees of the Department of Mathematical Modelling and FFS dean's office consult students on career opportunities. They are in close relations with potential employers – joint stock companies "Omnitel", "Bentley Systems", "Matrix", the public enterprise "GIS-Centras", etc.
76. The university students get various scholarships – incentive scholarships (nominal and other scholarships for good results), single grants and social grants. Nominal grants are awarded by the rector's order for outstanding study and research achievements. The grant is awarded by a competitive procedure. In the spring term of 2012-2013 the postgraduate of the technomathematics study programme Laisvūnė Valackaitė was awarded the most honourable first-degree Grand Duke Gediminas' scholarships. The size of the grant is 6 BSI - basic social benefits - (1 BSI is 130 litas).
77. Students can get loans to pay for studies, cover living expenses and to pay for periods of study in accordance with the international agreements. The loans are issued by the Lithuanian State Research and Higher Education Foundation (www.vmsfondas.lt).
78. Hostel accommodations for students are provided proportionally in compliance with the needs, social and financial state and the order approved by VGTU.
79. Students of the technomathematics study programme have an opportunity to broaden their knowledge during periods of studies in foreign higher education institutions. Students' visits under the ERASMUS exchange programme are organised by the VGTU International Relations Office. The Faculty of Fundamental Sciences has signed student and teacher exchange agreements under ERASMUS programme with 56 European and 6 Turkish universities. Postgraduates, though, seldom take advantage of this opportunity. From 2010/09/03 until 2011/01/31, the only postgraduate to go on student exchange programme was Juozas Krušna, who went to Riga Technical University in Latvia.
80. Students willing to participate in cultural and sportsmanship activities are welcome at the choir "Gabija", theatre studio "Palėpė", folk-dances ensemble "Vingis", VGTU sport and tourism club "Inžinerija", VGTU tourists' club "Turistas". The "Techmatic Olympics" are organised under the initiative of the technomathematics students. It is a set of activities, which merges studies and leisure time activities, and is aimed at promoting self-improvement, communication and cooperation.

6.4. The assessment of students' achievements

81. The examination session is carried out in accordance with a determined session organisation procedure (http://www.vgtu.lt/media/files/5/2013-2014-sesijos-tvarkos-ir-priedai/egzaminu-sesiju-ir-baigiamuju-darbu-rengimo-bei-gynimo-organizavimo-tvarka-685-pdf.pdf).
82. The postgraduates' knowledge assessment is regulated by the description of the VGTU students' knowledge assessment procedures approved by the VGTU Senate Resolution No. 51-2.4 of 31 May 2011. The criteria of students' achievements assessment are linked with the intended learning outcomes of the programme. The system of knowledge assessment criteria is criterion-proportional, according to which the students' knowledge level is assessed by the criteria in the study module and every grade matches the achieved study results. The knowledge of VGTU students is assessed on the basis of a 10-point grading scale and the acquired knowledge is assessed in accordance with the ECTS system scale. Knowledge is assessed and credited using VGTU grade equivalents in accordance with the ECTS scale, which is provided in Table 6.3.

Table 6.3. VGTU grade equivalents according to the ECTS scale

VGTU mark	ECTS scale		
	Grade	Assessment	Percentage of students who got such

			grade
10	A	EXCELLENT: work is done well, there are some minor mistakes	10 %
9	B	VERY GOOD: work is better than the average, there are several mistakes	25 %
8 7	C	GOOD: good work, but there are significant mistakes	30 %
6	D	SUFFICIENT: pretty good work but there are essential drawbacks	25 %
5	E	SATISFACTORY: work meets minimum requirements	10 %
4	EX	UNSATISFACTORY: it is necessary to work more in order to pass the course	–
3, 2, 1	F	UNSATISFACTORY: much more work is necessary	–

83. The calculation formula of postgraduates' achievements assessment, which defines the results of the study subject, is provided in the module card of the corresponding course unit. Module studies of each subject are finalized with an account. The account is assessed by a grade or pass/fail. The intended accounting types in the technomathematics study programme are: examination (E), course project (CP), account (Ac), report (R), final thesis/project (FT).
84. The information on learning outcomes' assessment criteria and the assessment procedure are published on the VGTU website http://www.vgtu.lt/media/files/5/51-2-4-studentu-ziniu-vertinimo-tvarka--1.pdf, also, on the website for students "Mano.vgtu" http://mano.vgtu.lt/informacija-studentams/studiju-procesas) and on the department website http://www.fk.fm.vgtu.lt/studijos/. Postgraduates find out the assessments for exercises and laboratory works they get during studies directly from the teacher and the examination assessments from the VGTU information system "Alma Informatica" on: https://medeine.vgtu.lt/studentams/login.jsp. The results of the course projects (works) defence are recorded in UIS before the beginning of the session.
85. At the first lesson every teacher explains the structure of the assessment score to the students. The assessment grade of learning outcomes consists of the student's accumulated score for the assignments intended in the study subject module, a score for the midterm accounts on theoretical problems and the assessment for the examination during the examination session. If students do not complete assignments intended in the study subject module card, they are not allowed to take the examination. The examination assignments are to be done in writing. After the examination in writing, the examiner can determine the student's knowledge during additional conversation.
86. When the examination results are published in the VGTU UIS, the postgraduate has a right to discuss his work with the teacher. During the discussion the assessed and checked work is not to be corrected. If students are dissatisfied with the examiner's explanations and arguments, they can refer to the VGTU rector's approved order No. 545 of 21 May 2012 "On the description of the procedure of the VGTU students' appeal lodgement for the knowledge assessment and examination", and within 10 calendar days after the accounting date they can file a motivated appeal in writing to the head of the Department of Mathematical Modelling due to infringements of knowledge assessment or/and knowledge assessment procedures. When the head of the department receives the appeal for the insufficient score of the knowledge assessment, he constitutes a commission of 3 department teachers. If the appeal is filed due to the infringement of the knowledge assessment procedure, the fourth number is involved – a representative from the university students' representation. The appeal is to be examined not earlier than the third day and not later than the fifth day after the appeal registration date. When the commission gets the student's and the teacher's point of view, they make a decision by voting. The head of the department is to give a copy of the appeal commission's meeting protocol to the dean of the faculty, where the appellant studies.
87. Data on the students' study progress is provided in Table 6.4.

Table 6.4 Data on the students' study progress.

Admission year	2008	2009	2010	2011
Graduation year	**2010**	**2011**	**2012**	**2013**
The number of students admitted	23	14	11	7
The number of dropouts	7	9	7	3
Graduates' weighted average	**8,159**	**8,312**	**7,888**	**8,051**

88. The students' progress is revealed by analysing examination results of the postgraduates. The study results indicate (Table 6.4) that the weighted average is 8.1. After the evaluation of students' progress, it was noticed that the weighted average of entrants' was slightly higher in 2009.
89. The duration of the technomathematics study programme is 3200 hours. The general duration of the programme contact teaching (classroom, laboratory and workshops) is 765 hours (about 24 per cent of the programme scope). 450 hours are devoted to lectures (59 per cent for contact hours), 165 hours are devoted to laboratory works (21 per cent), 150 hours for practical studies (20 per cent). One week of individual is planned during every semester. 76 per cent of study time is devoted to postgraduate's individual studies. There is enough time to acquire additional knowledge and develop general and special abilities.
90. 12 credits in the technomathematics study programme are given for elective courses. In the second semester students choose 5 subjects, in the third semester there is a free choice of 7 credits. Students choose subjects they need taking into account what knowledge they would like to improve according to the topic of their final thesis. Students have an opportunity to coordinate the topic of their final thesis with the department, the employer and their advisor in compliance with their wishes and the topic demand in the market.
91. The control of postgraduates' integrity is assured in two ways: by encouraging honest studies and taking precautions against dishonest behaviour. In order to minimize students' dishonesty during their studies, postgraduates are given individual and group assignments during practical trainings. If the period to perform the assignment is long, then there are intermediate accounts. When the facts of student's cheating or other kinds of dishonesty are discovered during the examination, the teacher puts "dishonest" into the examination record. The dean imposes the penalty. The smallest penalty for such behaviour is to repeat the respective subject; the maximum penalty is expelling from the university. In some cases, when the postgraduate submits a motivated request, the rector or the vice-rector for academic affairs makes the final decision as to the extent of penalty. The papers are submitted in the electronic version and checked virtually to determine the originality of the prepared work. Together with the term project or the final thesis the postgraduate submits the signed declaration of integrity, where he indicates that his work was written independently, the information in the work/project is not plagiarized, the quotations were used from information sources directly/indirectly, the literature references are marked. Annotations of final theses, electronic variants of final theses, and term projects are stored in the archive of the department. They are constantly checked to avoid the repetition of the assignment, dishonest work or plagiarism. According to the transfer – acceptance act, the electronic variants of final theses are transferred to the VGTU archive and stored there for 5 years.
92. The list of the graduates' final theses of 2010 - 2013 including the topic of the final thesis, the student, the academic advisor and his evaluation are provided in Annex 5. The lists of the topics of final theses together with annotations in Lithuanian and English are available on the website of the Department of Mathematical Modelling http://www.mmk.fm.vgtu.lt/en/studies/final-work-annotations. The topics of final theses correspond to the aims and learning outcomes.

6.5. Employment of Graduates

93. Almost all students in the Technomathematics Master's study programme work so they don't have any employment problems. On the one hand, it is a positive aspect, on the other hand, it is difficult for them to focus on their studies and this is one of the most frequent reasons for discontinuing their studies.
94. The event "Career Days" is held in VGTU every year. All information about career prospects and job offers is published on the programme website http://www.techmat.vgtu.lt/. Both the VGTU Integration and career office and the Dean's Office of the faculty provide consultations on employment issues.

95. The programme graduates of 2010 – 2013 did not use the services of the Lithuanian Labour Exchange. The graduates' employment is not usually directly related to their acquired education, they find a job in state institutions, business enterprises or education institutions. They work successfully with information technology and its application in the related spheres. They work as programmers, IT specialists, data analysts, project managers. Some graduates continue in the PhD studies in the Department of Mathematical Modelling, one graduate – in the VGTU Mechanical Engineering Research Institute. The programme graduates work in such companies as Bentley Systems Ltd., Informacinė raida Ltd., the public enterprise "GIS-Centras", Barclays TCL, AB "FL Technics", the public institution Project Management Centre, JSC ProboNova Medical Innovations, AB Swedbank and other.
96. The graduates of the technomathematics programme have good opportunities to react adequately to the trends of science and technology development and changes in the labour market. It is assured due to not only the knowledge of three perspective science fields (mathematics, informatics and engineering), abilities and skills to do independent research, but also the expected growth of the sector of research and applied activities, which requires such specialists. The education acquired by the programme graduates enables them to not only work as qualified researches in technically-oriented research and industry institutions, enterprises or higher education institutions but also continue in PhD studies.

Table 6.5. The strengths, weaknesses and improvement actions of the study process and its evaluation in the study programme

Strengths	Weaknesses	Improvement actions
Motivated students choose these studies (the admitted students' high competitive score average).	Low students' international mobility	The increase of study internationality by developing joint technomathematics study programme with other universities in the Baltic States..
Clear system of student knowledge assessment.	High number of dropouts.	

7. Programme management

7.1. Programme management and decision-making structure

97. Programme management, decision-making and control are carried out at different levels:
    1. At the state level– the Ministry of Science and education of the Republic of Lithuania – by adopting general standard resolutions.
    2. At the university level – the VGTU Senate and the rector by adapting national standard resolutions regulating the study organisation and adopting relevant documents.
    3. At the faculty level – FFS Dean's Office, within delegated functions – vice-deans, FFS council. The faculty has a study committee for solving study issues. The study committee's competence is to discuss and submit newly prepared or improved study programmes and programme course units. The faculty organises and controls the study process of particular study programmes: the lectures of the semester, the timetables of the examination sessions are approved, studies of elective subjects are coordinated, the study relations among faculties are regulated, proposals for the study process and quality improvement are submitted to the VGTU Senate. FMF council adopts resolutions, which regulate the study organisation in the faculty, research and other activities. The council also approves the amendments to the study programme.
    4. At the department level – carried out by the technomathematics study programme committee (Committee) and the study programme teachers. The committee consists of 7 members: the representatives of the departments of Mathematical Modelling, Strength of Materials, Engineering Mechanics, social partners and students' representatives. At this level, certain issues of the study process organisation, material and methodological provision, study quality improvement, distribution of teachers' workload, the replacement of the course units, the relations with stakeholders, the development and approval of the new course units and descriptions, the appointment of the academic advisors and reviewers for the final theses and other similar issues are solved. The committee is responsible for the study programme supervision pursuant to the requirements of the normative acts. If

it is planned to introduce amendments to the programme, first of all the changes are to be presented to the faculty committee for approval, and if the committee approves them, the study programme is renewed and the information is published on the VGTU website https://medeine.vgtu.lt/programos/profakult.jsp?pg=f&kva=B&metai=2013. At present the programme committee consists of: prof. dr. habil. Raimondas Čiegis, prof. dr. habil. Rimantas Belevičius, assoc. prof. dr. Teresė Leonavičienė, assoc. prof. dr. Jevgenijus Kirjackis, assoc. prof. dr. Stanislav Stupak, dr. Ramūnas Šablinskas (social partner) and Anastasija Antul (student representative).

98. Students' interests are represented by the students' delegated representatives in both the programme study committee and the Faculty study committee and Faculty Board.

7.2. Internal study quality assurance

99. The study quality is one of the most important VGTU priorities. The quality assurance policy is based on the principle of participation of the entire academic community in study quality monitoring, assessment and assurance processes, on the responsibility of every member of the academic community assumed according to the position, competence and commitments and directed to maintain the study process quality. In accordance with such principles, the responsibility is divided at all levels, starting with the students and ending with the Rector's Office and the Senate:
    - students are responsible for their individual learning outcomes and individual study quality. They are to follow the requirements for the academic discipline, students' code of ethics and other requirements for the university academic community in order to assure the study quality;
    - teachers are responsible for the quality of the subject they teach – for the compliance of the delivered material with the up-to-date research achievements, the quality of the classroom work, selected teaching methods, the application of the teaching methods for students' individual needs;
    - the departments and faculties are responsible for the study programmes' quality and their implementation - the compliance of the study programmes with the needs of contemporary society, research achievements, the quality of the individual subjects curricula, their constant update and compliance with the study programme;
    - offices and centres are responsible for helping the faculties;
    - other academic units who are responsible for the study process organisation - for the quality of the fields assigned for them;
    - the Senate is responsible for the study programmes' approval, establishing requirements for the study ethics, the establishing and improving the system for inner research and study quality assurance, etc.;
    - the vice-rector for academic affairs is responsible for the activities of the university units which are responsible for the study quality assurance and which are within his competence.
100. The general study quality assessment and assurance are based on European internal education quality assurance provisions, provisions of Dublin qualifications' and Lithuanian Centre for Quality Assessment and include: a) the quality assurance policy and procedures, b) the approval of the study programmes and qualification awards, monitoring and periodic evaluation, c) assessment of students' results, d) assurance of teachers' competence quality, e) learning resources and student support, f) information systems and g) public information.

7.3. Documents regulating the internal study quality assurance in a higher education institution

101. VGTU study programmes and quality assessment procedures, the assurance of their quality and the responsibility of those who implement the programme are described in the documents of different levels: in VGTU vision, mission, the description of the model of research and study quality management system, sustainable development plans, Statute, study regulations, general university procedures, subdivision quality policy, the programme and module descriptions, teaching methods, orders and other internal and external documents that regulate study and research activities.
102. The study quality is assured by complying with the VGTU Senate's resolutions and following VGTU Rector's orders:
    - The regulations of Vilnius Gediminas Technical University study committee (resolution No. 6-2.5 of 2 March 2005);

- The regulations of Vilnius Gediminas Technical University studies (resolution No. 58-3.1 of 26 June 2012);
- The general regulations of the faculty of Vilnius Gediminas Technical University (resolution No. 57-1.4 of 29 May 2012);
- The regulations of the faculty‘s study committee of Vilnius Gediminas technical university (resolution No. 6-2.6 of 2 March 2005);
- The general regulations of the faculty council of Vilnius Gediminas technical university (resolution No. 57-1.5 of 29 May 2012);
- The general regulations of the department of Vilnius Gediminas technical university (resolution No. 57-1.6 of 29 May 2012);
- General principles of the formation of the second-cycle study programmes (resolution No. 57-1.9 of 29 May 2012);
- The description of the order for the full-time and extended studies (resolution No. 57-1.7 of 29 May 2012);
- The description of the procedure for the study programme reform (resolution No. . 57-1.10 of 29 May 2012);
- The regulations of the planned study programme internal assessment of Vilnius Gediminas Technical University (resolution No. 8-2.1 of 25 May 2005);
- The description of the study results inclusion procedure at Vilnius Gediminas Technical University (resolution No. 55-3.2 of 31 January 2012);
- The description of the procedure for Vilnius Gediminas Technical University teachers‘ internships (resolution No. 44-1 of 4 May 2010);
- The description of the procedure of Vilnius Gediminas Technical University students‘ knowledge assessment (resolution No.51-2.4 of 31 May 2011);
- The teachers’ ethics code of Vilnius Gediminas Technical University (resolution No. 14-2.5 of 10 May 2006);
- The procedure of VGTU teachers’ training (resolution No. 22-4 of 25 June 2003).
- The description of the procedure for the preparation of examination sessions and final theses and the organisation of their defence at Vilnius Gediminas Technical University in 2011–2012 (order No. 542 of 16 June 2011, order No.412 of 5 April 2012);
- The description of the procedure for the preparation of examination sessions and final theses and the organisation of their defence at Vilnius Gediminas Technical University 2012–2013 (order No. 576 of 25 May 2012);
- The description of the procedure for Vilnius Gediminas Technical University students‘ knowledge assessment appeals submission and consideration (order No. 545 of 21 May);
- The description of the procedures for premature examination of Vilnius Gediminas Technical University‘s students going abroad under cultural exchange and work programmes (order No. 459 of 23 April 2012).

103. All the information about the programme implementation is stored in the VGTU information system “Alma Informatika“. On top of that, information is stored in the department, the Dean’s Office, VGTU Academic Affairs Office. These subunits also store protocols of programme consideration and assessment.
104. The system of the university study quality assurance is based on the provisions of the European area of higher education quality assurance. The system of the quality management is the essential component of the strategic management, assuring the quality of the implementation of the strategic planning and measure implementation quality. The internal system of the quality management assures the implementation quality of University’s mission, aims in the study field – to train, and develop a responsible, creative, enterprising, competitive personality who is susceptible to new technologies and cultural values; to carry out studies providing contemporary university education, higher education qualification.
105. In 2012 the university started to implement the project “Introduction of VGTU Internal Study Quality Management System“. The main aim of the project is to assure efficient and fruitful employment of managerial resources in order to increase the quality of services provided by the university. The project includes the analysis of the VGTU activities and the preparation and implementation of the quality management model based on it. There are also intentions to develop and implement a management and

monitoring tool of the Quality management system. The project includes implementation of the efficient monitoring system which will allow the university to quickly react to the users' and other concerned parties' expectations and assure necessary measures to improving competitiveness of the higher education institution. By implementing the provisions and guidelines of the European higher education quality assurance, as well as by assuring the internal study quality, the university implements different processes and procedures:

− the approval of study programmes, monitoring and assessment (*The general principles of the first-cycle study programmes formation, the description of the procedure for the implementation of the full-time and extended studies, the regulations of the internal assessment of VGTU intended study programmes*), the submission of methodological material (*The description of the procedure for the study programme reform*); study programmes are given to the Study quality assessment centre to assess and accredit them according to the procedures set by the Ministry of Education and Science;

− the system to assess the students' learning outcomes (*The description of the procedures for the inclusion of study learning outcomes at VGTU, the description of the procedures for the VGTU students' knowledge assessment, the description of the procedure for the VGTU students' knowledge assessment appeal submission and their consideration*);

− The system to improve teachers' academic competence (*procedure for VGTU teachers' training*);

− The assurance of study resources and academic, cultural and social support for students: *the Academic Affairs Office's group for students' issues, VGTU library, Aesthetic education centre, Sports and Tourism Club "Inžinerija", the students' representation office*;

− provision of career services: *The Integration and Career Office*;

− students' participation in the quality assurance activities: *The Academic Affairs Office, Faculties – assurance of feedback.*

7.4. Feedback in the study quality process

106. Students are the main party concerned with the study quality and they can contribute to the study quality improvement by collaborating with teachers and the administration. The way that gives all the students an opportunity to participate in the study improvement process is providing feedback on studies expressing their views in the surveys organised by the university..
107. The feedback is assured by systematically carrying out student' surveys and using the generalised survey results to improve study programmes, the study process organisation, to build capacities of the academic staff.
108. VGTU carries out three kinds of surveys:
    1. All university students' survey on the taught subjects and the teachers who delivered the subjects.
    2. The study of the first-year of the first-cycle students' opinion of their choice of studies at the university.
    3. The survey of the first -year second-cycle students about the bachelor's study quality.
    4. In 2012, the university started the survey on the study conditions.
109. Since 2007 an automated system of students' surveys has been successfully introduced at the university information system http://medeine.vgtu.lt/studentams/login.jsp. With the help of this automated survey system student surveys about the taught subjects and the teachers are organised twice a year: after winter and spring sessions. During the surveys the teaching quality, the quality of teaching methods, prepared material and the preparation for lectures are assessed. The survey questionnaire is based on the test principle, i.e. the answer to a question is chosen from the given variants. The teacher can see individual results of his survey by connecting to the university's information system through "Lecturers" field. Considering the results of the students' surveys teachers can improve their teaching methods.
110. The postgraduates' survey results are discussed in the meeting at the rector's office, in the Department of Mathematical Modelling and at the meetings of FFS Study committee. During the meetings participants try to find out the factors which influence the students' opinion, make necessary decisions how to improve the teaching methods. The study quality is assessed and improved in compliance with the feedback results. However, it is necessary to admit that the obtained information during surveys covers the opinion of few students only, so it cannot be very efficient. The teachers' opinion on the study programme is not analysed while assessing study programmes.
111. Every year, are meetings with students are held by the initiative of the study programme developers, during this meetings various important academic issues are discussed. During the discussions, the developers get remarks and proposal concerning the study process organisation, students' motivation, etc.

7.5. Stakeholders' involvement and participation in the programme assessment and improvement processes, their impact on programme development.

112. Social partners are members of the programme monitoring committee, the faculty study committee and the faculty council. They participate while solving study programme assessment and improvement issues, submit proposals. Employers are involved in the programme assessment process as chairpersons of the qualification degree providing commission. The process of the final theses defence and the results, employers' and students' proposals and remarks are periodically discussed at the department meetings. The general recommendations on the preparation of final theses and their quality improvement are accepted by consensus. Direct contacts with employers are maintained in organised conferences, seminars and during business meetings.
113. The programme is publicized via the social network Facebook https://www.facebook.com/pages/Technomatematika/174310625932263/, on the technomathematics study programme website http://www.techmat.vgtu.lt/, and website (https://medeine.vgtu.lt/programos/profakult.jsp?kva=B&pg=f&metai=2013)/. The programme is also publicized during different fairs, which are devoted to studies and are usually held in the LITEXPO exhibition centre. Every faculty and the university arrange open-door days where the technomathematics study programme is presented.
114. Many teachers of the second-cycle programme teach in the technomathematics first-cycle programme too. They contribute to promoting the programme among the technomathematics bachelors. The first-cycle programme graduates constitute the majority in the technomathematics master's degree.
115. In 2011, while analysing the situation of the technomathematics study programme, a group of teachers involved in the technomathematics study programme prepared a "Possibilities Study" http://www.techmat.vgtu.lt/skelb_files/JM_GalimybiuStudija.pdf, where they studied the advantages and disadvantages of the study programme and framed \ programme improvement guidelines.

Table 7.1. Strengths, weaknesses and improvement actions of the study programme management

Strengths	Weaknesses	Improvement actions
There is an internal study quality assurance system; clearly distributed responsibility in the study programme management processes.	Stakeholders and teachers participation in the improvement processes of the quality management system is insufficient.	The further development of the programme management is linked with the maintenance and increase of stakeholders' involvement.
Students, teachers, representatives of employers are involved in the study quality assessment processes.		Students should know that their participation in surveys is important for the study programme improvement and they should be encouraged informally to get involved in the process.
		Teachers have to participate assessing the programmes they work in.