



STUDIJŲ KOKYBĖS VERTINIMO CENTRAS

Kauno technologijos universiteto
STUDIJŲ PROGRAMOS TAIKOMOJI MATEMATIKA
(valstybinis kodas - 612G10002)
VERTINIMO IŠVADOS

EVALUATION REPORT
OF APPLIED MATHEMATICS *(state code -612G10002)*
STUDY PROGRAMME
at Kaunas University of Technology

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Išvados parengtos anglų kalba
Report language – English

DUOMENYS APIE ĮVERTINTĄ PROGRAMĄ

| | |
|--|------------------------------|
| Studijų programos pavadinimas | <i>Taikomoji matematika</i> |
| Valstybinis kodas | 612G10002 |
| Studijų sritis | Fiziniai mokslai |
| Studijų kryptis | Matematika |
| Studijų programos rūšis | Universitetinė studijos |
| Studijų pakopa | Pirmoji |
| Studijų forma (trukmė metais) | Nuolatinė (4); iššęstinė (6) |
| Studijų programos apimtis kreditais | 240 |
| Suteikiamas laipsnis ir (ar) profesinė kvalifikacija | Matematikos bakalauras |
| Studijų programos įregistravimo data | 1997-05-19 |

INFORMATION ON EVALUATED STUDY PROGRAMME

| | |
|---|------------------------------|
| Title of the study programme | <i>Applied mathematics</i> |
| State code | 612G10002 |
| Study area | Physical sciences |
| Study field | Mathematics |
| Type of the study programme | University Studies |
| Study cycle | First |
| Study mode (length in years) | Full-time (4). Part-time (6) |
| Volume of the study programme in credits | 240 |
| Degree and (or) professional qualifications awarded | Bachelor of Mathematics |
| Date of registration of the study programme | 1997-05-19 |

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The Centre for Quality Assessment in Higher Education

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I. INTRODUCTION

1.1. Background of the evaluation process

The evaluation of on-going study programmes is based on the **Methodology for evaluation of Higher Education study programmes**, approved by Order No 1-01-162 of 20 December 2010 of the Director of the Centre for Quality Assessment in Higher Education (hereafter – SKVC).

The evaluation is intended to help higher education institutions to constantly improve their study programmes and to inform the public about the quality of studies.

The evaluation process consists of the main following stages: 1) *self-evaluation and self-evaluation report prepared by Higher Education Institution (hereafter – HEI)*; 2) *visit of the review team at the higher education institution*; 3) *production of the evaluation report by the review team and its publication*; 4) *follow-up activities*.

On the basis of external evaluation report of the study programme SKVC takes a decision to accredit study programme either for 6 years or for 3 years. If the programme evaluation is negative such a programme is not accredited.

The programme is **accredited for 6 years** if all evaluation areas are evaluated as “very good” (4 points) or “good” (3 points).

The programme is **accredited for 3 years** if none of the areas was evaluated as “unsatisfactory” (1 point) and at least one evaluation area was evaluated as “satisfactory” (2 points).

The programme **is not accredited** if at least one of evaluation areas was evaluated as "unsatisfactory" (1 point).

1.2. General

The Application documentation submitted by the HEI follows the outline recommended by the SKVC. Along with the self-evaluation report and annexes, the following additional documents have been provided by the HEI before, during and/or after the site-visit:

| No. | Name of the document |
|-----|--|
| 1. | Guidelines for study programme improvement |
| 2. | Marketing material |

1.3. Background of the HEI/Faculty/Study field/ Additional information

The Applied Mathematics Bachelor Programme in the field of Mathematics is carried out by the Faculty of Mathematics and Natural Sciences, Kaunas University of Technology. The Expert Team visited the Faculty on May 9-10th. First, the Expert Team met the administrative staff of

the Faculty. Next, at the meeting with staff members responsible for preparation of the Self-assessment report the Expert Team was given answers to the questions concerning less covered in the Self-assessment report issues. After that, a meeting with members of teaching staff took place. The Expert Team had possibility to observe various study support services (class rooms, computer services, library), as well as to familiarize with students' final thesis work. The Expert Team conducted also interviews with students. The Expert Team was familiarized with students' attitude towards the study programme. The meeting was carried out in an active and constructive atmosphere. The students expressed positive as well as critical opinions about the programme. In the following, the findings of the Expert Team are outlined. The Self-assessment report submitted by the Faculty, the observations made at the time of the visit, and the supplementary material received during the visit form the basis of these assessments.

1.4. The Review Team

The review team was completed according *Description of experts' recruitment*, approved by order No. V-41 of Acting Director of the Centre for Quality Assessment in Higher Education. The Review Visit to HEI was conducted by the team on 09, May, 2017.

1. **Prof. Miklós Hoffmann (team leader)**, *Full Professor, Head of institute of mathematics and Computer Science, Eszterhazy Karoly University, Hungary;*
2. **Prof. Neda Bokan**, *Former Professor of the University of Belgrade, Serbia;*
3. **Assoc. Prof. Ants Aasma**, *Associate Professor, Department of Mathematics and Finance , Tallinn University, Estonia;*
4. **Mr. Marijus Mikalauskas**, *CEO of insurance company "Būsto paskolų draudimas;*
5. **Mr. Henrikas Vaickus**, *student of Vilnius University study programme Physics of Energy.*

Evaluation coordinator – Mr. Pranas Stankus.

II. PROGRAMME ANALYSIS

2.1. Programme aims and learning outcomes

The Applied Mathematics Bachelor Programme in the field of Mathematics is carried out by the Faculty of Mathematics and Natural Sciences, Kaunas University of Technology. The declared programme objectives and implementation are clearly defined and fully in line with European and Lithuanian higher education recommendations, standards and legal requirements. The title of the programme well reflects the goals of the programme. The objectives perfectly fit the mission, operational objectives and strategy of the Kaunas University of Technology. The review team acknowledges the fact that – in spite of the suggestion of the precedent evaluation

report – the title of the degree awarded is still „Bachelor of Mathematics” instead of Bachelor of Applied Mathematics, due to national legislations, which are currently under revision.

The intended learning outcomes of the Programme are well presented in the SER, and are publicly announced, which is an asset. These objectives correspond with Dublin descriptors and cover scientific and soft skills as well. According to the formulated learning outcomes of the Programme students are supposed to obtain knowledge and understanding of the basic concepts, definitions and proofs from major areas of mathematics and the ability to apply them to the solution of theoretical and real-life problems; knowledge and skills of mathematics and computer sciences necessary for the analysis, prognosis and optimal control of technical and business systems, creating mathematical models of these systems and applying them, to interpret and clearly communicate results, maintaining professional competence through life-long learning.

These outcomes and the curriculum itself are declared to be designed in response to societal and especially to labour market needs. Although these needs are adequately presented in the SER, it could be even better structured beside occasional meetings how and when industrial and further non-educational partners can provide regular feedback and support to continuously improve the content of the Programme. The learning outcomes are well assigned with modules and courses, which is credible. There are two possibilities to study applied mathematics in this Programme: after finishing the core subjects one can either choose more elective courses in this field, or (in case of double degree studies) choose a minor study field.

The description of the Programme does not pay full attention to the distinction between these two paths, and outcomes gained by core subjects and by elective subjects. It is not entirely clear from the description provided for students, how the gained skills and competences depend on the type of future studies (major or minor), more specifically if all the planned outcomes are gained even if one attends only the core part of the curriculum without electives (as supposed) then what knowledge and research skills and competences can be gained by the elective courses. The obligatory diploma supplement with the description of the elective part attached to the diploma is a plus in this regard. Major and minor study fields subjects are sometimes performed at two faculties independently - it is necessary to introduce subjects, joint works to build “bridges” between these fields. However, the review tema acknowledges this issue as more related to curriculum design and only partially related to programme learning outcomes. The programme learning outcomes are very well prepared and connected throughout the study programme.

2.2. Curriculum design

The curriculum of the study programme Applied Mathematics BSc has 4 years and part-time 6 years forms. Study programme scope for both forms is of 240 ECTS. These two options allow students to choose the one which is in conformity with their needs and life conditions, as some of them already have a job in compliance with the study programme. A proper job is one of good motivations for this programme chosen.

The programme comprises the general university courses of 15 ECTS credits, Subjects of the major study field take 171 ECTS credits or 165 ECTS credits in case of double degree studies. According to SER University appointed the student's elective subjects take 54 ECTS: subjects of the major study field specialization courses take 30 ECTS and entrepreneurship education, personality development, socio-economic environment knowledge and optional courses take 24 ECTS. In case of double degree studies electives of Minor Study Field take all 54 ECTS. Programme is finished by the final practice of total 15 ECTS and the final degree project with 15 ECTS. Therefore the review team concludes the study programme scope, structure, subjects meet the legislative requirements of the Mathematics Study Field Description and the General Description of the Requirements on the Degree Granting for the First Cycle and Integrated Study Programme. During the meetings with Alumni representatives and social partners the review team learned they support the study programme with major and minor field, as it offers a broader knowledge.

Student's workload is determined in accordance with KTU temporary academic regulation. By this regulation 2304 hours (37.7% or 43.9% without final practice and final degree project) are appointed for contact hours at the study programme, 3696 hours (62.3%) for students' individual work. The ratio of contact hours and hours for individual works shows that students may acquire not only subject-specific skills but also creative skills, ability of lifelong learning, analysis of the solution in practice under uncertain conditions, etc.

Subjects of the study programme Applied Mathematics are taught in a consistent manner. Description of study subjects is really well organized. It involves all details (prerequisites, course learning outcomes, programme learning outcomes, teaching/learning methods, assessment methods, recommended semesters for enrolling of courses, etc.) important for acquiring of the aim of subjects separately as well as of the study programme at all. All subjects are classified into several levels. The first one involves major and minor study field, then compulsory courses, specialization subjects, elective courses, etc. with recommended semesters for enrolling these subjects to have logically consistent study plan for each student.

However, analysing the description of some study subjects review team did observe some slight improvement which could be done. The syllabus of Discrete Mathematics involves sections and themes: 1. set, functions, relations, induction, 2. elements of general algebra, 3. an

introduction of logic, 5. an introduction to graph theory. All these themes belong to corresponding courses in study plan of this programme. In the course Mathematical Analysis 1 among themes in syllabus one can find elements of mathematical logic and the theory of sets, etc. In the course Geometry there exist themes: 1. matrices and determinants, 2. linear systems, the rank of matrix.

Prerequisites for some courses either do not exist (for example Discrete Mathematics) or are not well defined (Mathematics for Physics 1; Mathematics and Informatics for Engineering Economics; Mathematics, Physics, Computer Programming for Physically Based Animation, etc.). The prerequisites need to be clearer and carefully defined. The recommended literature involves many items for some courses: for Risk and Uncertainty Analysis 6 references and 31 additional literature; Basics of Communication 6 references and 19 additional literature; etc. During the meeting with teaching staff the review team has learned that students have majority of courses teaching materials available via Moodle platform and hence recommended literature comprises many references to improve knowledge of good students. The review team emphasizes the courses of Algebraic Structure, Mathematical Methods of Signal Processing, Foundation of Object-Oriented Programming 1, 2, etc. with well-prepared description.

The content of subjects (modules) corresponds to the type and cycle of studies. It includes the fundamental mathematical subjects: mathematical analysis, differential equations, probability theory, statistics, algebra, analytical geometry, discrete mathematics, as well as main informatics subjects: object-oriented programming, data analysis, etc. in initial semesters that are in compliance with the legislative requirements. In this way students can expand knowledge in a specific area and achieve competences and learning outcomes intended by this study programme. Since the study programme is designed with an eye on future labour market, it requires a new approach to curriculum design in some details which would imply benefits for students and a proper role of applied mathematics in labour market as well as in its development. The review team identified some lack of geometry, and topology in the study programme. More substantial explanation of the need of theoretical subjects is very important and it may be acquired by presentation of real problems, and good examples chosen from application area as motivation to acquire the goal. This approach might motivate students to be more interested in theoretical courses which are important in solving of real-world problems and ability of further appropriate development of applied mathematics, but in a students' study period unrecognized.

The content of subjects (modules) and study methods enable to achieve the intended learning outcomes. There exist some minor possible improvements. For example, it is not clear why is the topological classification of surfaces and some other topics involved into the course Geometry, as Topology is not involved in the list of courses. It is not clear what the motivation

to involve that part of content is. Maybe, because of linear programming, it would be better to involve geometry of n-dimensional Euclidean space. The content of Discrete Mathematics could be modified to exclude graph theory, elements of general algebra, logic, sets, functions, relations and to involve the more appropriate content for this course.

There exist recognizable differences between study methods of classical courses (Mathematical Analysis 1, 2, Linear Algebra, Geometry, etc.) and some others (Mathematical Methods of Signal Analysis, Modelling of Business Processes and Systems, Object-Oriented Programming, Physics 1, 2, etc). The previous review team have also recognized these differences and have recommended changing teaching/learning and assessment methods for some courses. Study/learning method of some courses up to now are organized in a way to use only ex-cathedra style of teaching in that set of courses. It would be beneficial to change teaching/learning methods in all courses, including a project-based learning methods, using software packages that students become more active during contact hours.

The study programme scope is sufficient to achieve the learning outcomes. In this spirit the subjects chosen from pure mathematics, informatics, specialization subjects and elective courses play an important role as well as the proper distribution of credits.

The curriculum is designed in such a way that in the third and fourth years are presented in many courses, especially elective ones (Modelling of Business Processes, Intelligent Software Decision, Data Warehouses and Business, etc.) the latest academic and technological achievements (application of various software packages, etc.). The first two year are devoted to the acquiring of theoretical knowledge in classical fields, except geometric and topological foundations. The internship, organized in companies are appropriate as well as bachelor thesis with the task proposed in companies considering their real problems. It would be well to avoid internship inside the University and to avoid bachelor thesis with topics not related with applied mathematics.

2.3. Teaching staff

In total there are 32 lecturers affiliated with the Programme; 30 lecturers are full time employees at KTU. The academic staff, working in the Programme, consists of 8 professors, 17 associate professors and 7 lectures (5 with PhD). The age distribution of the academic staff of the programme will see the replacement of several high qualified lecturers within a few years; 6 persons are older than 65 and 6 persons 60-65 years old. This will provide an opportunity to attract young academics with new research competences and new ideas for teaching and learning to KTU.

The requirement that not less than 50% of study subjects are delivered by scientists is fulfilled, since 90% of the subjects are taught by persons having a scientific degree. The study programme to a great extent corresponds to the research interests of the teaching staff (didactics of mathematics, mathematical modelling, mathematical analysis, differential equations, numerical analysis, probability theory and statistics, time series analysis, complex systems, computer science and information systems, software engineering, industrial mathematics). However, KTU has no a specialist in geometry which should be improved in the future. 84% of courses are taught by teachers, who perform research in the field of taught subject (no less than 80% required).

During the assessment period, a large majority of teaching staff participated in various activities to raise their teaching skills and professional qualification. For example, courses for teaching staff: “KTU educational excellence development”, “Study programme update: learning outcomes and didactic system”, “Open and distance learning”, “Use of electronic sources of scientific information“, “Basis of video conferences methodology”, etc. Lecturers use traineeship possibilities at foreign studies and research institution, possibility to work of associated researcher at foreign studies and research institution. 10 lecturers working at the Programme took part at the scientific internships and international exchange programs. So the qualifications of the current academic staff is sufficient for achieving all the aims and learning outcomes set for the Programme, and surely meet the legal requirements.

2.4. Facilities and learning resources

The Faculty of Mathematics and Natural Sciences has a sufficient number of classrooms and laboratories for the study Programme. The premises used by the studies are adequate both as to the size and as to the quality. The academic premises generally conform to the requirements of occupational safety and hygiene. However, the administration of the Faculty pointed out in the self-assessment report the lack of workplaces for group works. The review team agrees with such weakness, which was discussed during the visit. More attention should be paid to contemporary accessibility standards of the multi-functional premises and lecture-rooms.

All teaching workplaces are equipped in appropriate level: auditoriums repaired during the last 6 years, computer classrooms renewed every 5-6 years (part of them renewed in year 2016), equipped by video and audio equipment, wireless internet access. The various software and programming tools used in the learning process are adequate and sufficient. The teaching materials and accessibility to the students are suitable. Moodle learning environment is used for

this purpose. The review team had a chance to visit distance learning laboratory which is beneficial.

The procedure of organization and management of students' internship is in place. Number of students in the program that performed internship in enterprises raised from 64% (year 2011-2012) up to 80% (year 2015-2016). The list of partners for professional internship is solid, including banks and insurance companies. However, some students performed internship in KTU. This practice should be eliminated and only business internships should be used as much as possible.

On the meetings with the students, they complain to the lack of workplaces for independent working outside the service hours of the library and during the free time from academic classes. During our visit to the library, the reading room was rather fully occupied by the students working with their laptops rather than using the literature. The library has the contemporary electronic catalogue with many necessary scientific databases present.

2.5. Study process and students' performance assessment

The admission process is clear and transparent. It is organised and conducted by the Association of Lithuanian higher education institution for organization of general admittance (lith. Acronym LAMA BPO). General admission system ensures even conditions, confidentiality for all applicants, guarantees a correct calculation of competition score and line up of applicants to the Programme. In addition, it is welcomed, that University established the minimal score 3 (in 2017). Considering that this Programme is one of the hardest in KTU and a high rate of drop out, it may be useful to increase it further in the future. High studies grades and average grades of final degree projects evidence, that composition of competitive score is adequate (competition score of the entrants to the Programme consist of Mathematics (40%), Lithuanian language (20%), Information technologies or Physics (20%) and one other educational subject (20%) grades), provides gifted students for this programme.

A wide variety of informational sources allows to find entrance requirements for all interested entrants (websites of LAMA BPO and KTU, annual information publications), there is an access to detailed curriculum of the programme. On the other hand, the highest drop-out rate in the 1st - 3rd semesters may reveal, that students joins the programme with a lack of information about it and the improvement of information of the programme could help to evaluate the reality of studies for the applicants. During the analysed period, almost all students were admitted to the state-funded places. To sum up, the results of the admission to the programme shows that a high numbers of applicants are attracted annually and the average

competitive score of admitted applicants is increasing in last three years (respectively 6,51; 7,12; 7,16), but the annual drop of the highest scores of admitted applicants (10,78 in 2014, 10,08 in 2015 and 9,46 in 2016) may show, that it is needed to improve the attraction of the most gifted students.

Organisation of the study process ensures proper implementation of the programme and achievement of the intended learning outcomes. There are options for a study process individualisation (minor studies and elective subjects). As a result, graduates have a good background on interdisciplinary subjects and knowledge application. Studies are flexible and compatible with other personal activities: a schedule is rationally harmonized annually in collaboration with students regards to their needs; consultations about study plan composition are available. The proportions between independent and contact work are adequate. The exam schedules preparation in agreement with the lecturer and students as well as ability to do missed semester tasks during the time of session allows achieving the intended learning outcomes less stressful and more fluent. The students during the visit witnessed these conditions. The review team noticed that although there is access to all needed software in the University, the private licenses for students would be welcome. With no doubts, the virtual means (i.e. Moodle) for study process implementation are used consistently; the majority of teaching materials are available online. This was confirmed during the visit.

The system of internships during the studies is exceptionally good and well developed: it is available to get it with a help of University or find it. There are intended aims for all internships, as well as final reports are needed after the practise. The University stays in contact with social partners and alumni in order to organise a high quality internships, which often leads to an employment. There is a working system of feedback from lecturers to students as well as the opposite feedback from students to lecturers. It is highly advisable, to continue the encouragement of students to fill the surveys about studies quality.

Students are encouraged to take part in scientific research. There are usual means for students' involvement to a scientific research: students are introduced to scientific research during the seminars, there is an option to have a mentor and participate in conferences or to join scientific programs and groups. Students have an opportunity to prepare their final degree projects in cooperation with business companies, which make programme's absolvents' knowledge more applicable in labour market. However, there is a lack of alternative means for a wider students' encouragement. As example, students' with high achievements employment to laboratories could be available. The current situation concentrates mostly only on the most gifted students, whose talents are obvious, which is evidenced by a comparative small number of students participated in mentorship program (4).

It is clear, that KTU makes effort to provide conditions for students to take part in mobility programmes. The University intensely extends the range of bilateral agreements in recent years, informational events are organised, it is foreseen, that 18 credits will be obligatory to have in English for language improvement. In addition, the development of students' mobility is intended in the strategy. Students, who took part in mobility programs are satisfied with the support of University, but mentioned, that there is an incorrect popular opinion between students of the programme, that mobility programs may cause some problems in study process. Consequently, the average number of outgoing students still should be improved.

The higher education institution ensures proper academic and social support. University provides actual studies' information in a few sources, which guarantees an efficient information spread between academic community. University pays extra attention for the freshmen introduction to the studies through additional courses and events, students are satisfied with the introduction to the studies. The University provides additional support and attention for especially gifted students and those, who have learning difficulties, this support was positively evaluated by students. There is a high level of students' career consultations and support, which is proved by very successful Career Days. The opinion of students in support processes is represented by Students' Broad. University gives adequate financial support for the Programme's students in case of financial problems or high achievements, including organisation of sponsors support. The improvement of the financial support was noticed after the reform. All students of KTU obtain psychological, fitness, health, and cultural support, there is a large choice of additional activities for leisure time. In the end, the need of dormitories is fully satisfied. It is clear, that student support is clearly in a high level.

The system of assessing student achievements is clear, public and appropriate. This is achieved through appropriate dissemination of information and introductory lectures. The system of assessing is clearly defined by internal regulations of University. Examination schedules are flexible and made in agreement with students. It is good that virtual information system is widely used for assessing implementation. As a drawback could be mentioned concerns some of the exams and assignments which are not updated/renewed annually, which could cause an inappropriate assessment.

The Faculty gathers information about the employability of graduates: in this way, the relation between graduates' skills/erudition and expectations of programme operators and employers are maintained. A very high percent of graduates' employment reveals that graduates (or even students) of the programme are very popular in the current labour market. One of the reasons is clearly an option of minor studies. Graduates are highly assessed by employers. In addition, extremely wide range of final projects 'titles confirm obtained wide knowledge of

graduates which may be used to compete in labour market. In conclusion, professional activities of the majority of programme graduates correspond to the expectations of programme operators and employers. Only sphere for improvement mentioned by social partners – more attention for applied subjects.

The programme corresponds to the state and international economic, social and cultural and future development needs. It is achieved by staying in touch with alumni and social partners. However, social partners expressed wish to participate more actively in the programme's development.

Fair learning environment is ensured, there is a legal basis, preventative measures. The exams are supervised, laboratory assignments are defended orally, all final projects are checked by anti-plagiarism software. The academic community emphasizes, that there are no examples of cheating cases: it is said, that there was no written complaints by students during 2010-2016. To conclude, everything shows that academic dishonesty problem is totally solved, but it is crucial to constantly make efforts to decrease a toleration or apathy of students in an academic honesty.

2.6. Programme management

The programme management, decision-making and control of the Programme are implemented on the basis of the KTU Statute, approved by the temporary Academic regulations of the University, other legal acts of the University and Lithuania which regulate the area of higher education. Study programme administration and internal study programme quality assurance activities are managed and coordinated by the Vice-Rector for Studies who is assisted by Study Department of the University Study Quality Assurance and Development, Student Affairs Department and other administrative units. The role of Senate, Faculty Council, Field Study Programmes Committee and other units in this procedures are clear described. Students and social partners have their own representatives in all management units in compliance with their interest.

In 2015, with the purpose for more effective management of the study programmes and for ensuring their quality, the University enhanced study programme management model. The Field's Study Programme Committees were established instead of the Faculty Programme Committee. It consists of lecturers (scientists), social stakeholders and students. Their work is regulated by Guidelines for improvement of KTU study. This is one of steps of improvement in responsibilities for decisions and monitoring of the implementation of the programme. During the meeting with teaching staff, students, and social partners the review team concluded that this new programme management model is more efficient with quality assurance benefit as well.

For the purpose of improvement of study quality the University has own feedback system. The procedures for feedback organizing are regulated by the Description of Feedback Organizing Procedures of KTU. Each year, University Survey Plan is prepared and approved. A systematic collection of opinions and feedback is organized from all study process participants: students, lecturers, graduates, employers and other groups. The general feedback results are discussed at the meetings of the Rector and Senate, Deans and Department; they are published on University Intranet. During the meeting with students the review team learned that this level of system seems quite complicated as they do not recognize their feedback as they expect. Students prefer more direct communications with teaching staff, which are also organized, and the corresponding feedback. However, the review team supports these analyses at the various levels as well as publishing on University Intranet. To provide a proper analysis of the achievement indicators the review team recommends to use more statistical data and conclusions by proper statistical methods although an improvement of the programme Applied Mathematics BSc is also recognized in this way.

The Field Study Programme Committee, on the basis of monitoring, evaluation, and accreditation conclusions, each year revises and updates study programme structure and contents, evaluates the quality of the study modules, their compliance to the aims and intended learning outcomes of the programme. Any major changes of the programme structure are approved at the Faculty Council. Students' representatives informed the review team they are active in round tables discussing quality of lectures and to propose their improvement which were considered and some implemented. The review team favours such management.

The outcomes of external evaluation of the programme are used for the improvement of the programme. Algebraic Structure, as a course, was involved into the undergraduate degree programme following the recommendation of the review team in previous external evaluation. Project-based learning was involved in many courses, but not in fundamental ones in mathematics. Besides the theoretical aspects of the course content – the key concepts and theorems, it was impossible to check analysing Descriptions of study subjects (Annex 4.2) how is organized the second component where the student need to learn to apply the theory by tackling exercises and problems assigned by teacher. During the meeting with students the review team learned that students obtain tasks for homework, but discussions of solutions during lectures or practice are not involved, except consultations by students request.

Elements of programming languages and tools are spread over some subjects, but not as much as possible (MATHLAB, etc. is not used in fundamental mathematics courses, as suggested in the previous external evaluation).

The evaluation and improvement processes involve stakeholders. Two social partners participate in the activities of the Faculty Council together with the Dean, 11 lecturers (scientists) elected from Faculty division, 4 representatives of the Students Agency. The function of the Council is to evaluate the recommendations of the Field Study Programme Committee (FSPC), provides proposals to the FSPC for the study programme package, new study programmes creation, etc. They participate also in FSPC, Faculty Attestation. The stakeholders emphasized their role in programme management comprises: (i) proposals for bachelor thesis, (ii) election of invited lecturers from companies for certain special courses, (iii) memberships in defence committee of bachelor thesis, (iv) discussion once per year to observe various problems of the University.

The internal quality assurance measures are effective and efficient in various aspects. But for a proper quality assessment is necessary to use more comprehensive statistical data, apply statistical methods to analyse them in order to derive corresponding conclusions. The full-time quality assurance of Mathematics field's study programmes is carried out following the University Quality Guidelines which complies to the guidelines and recommendations of the European higher education and major laws and legal acts of the LR regulating higher education. The important making-decision process belongs to other institutions on the University and the Faculty levels. From 2013 onwards, twice a year, during the autumn and spring semesters, "Round Tables" are organized that students representative, the Fields Study programme Director, administration representative discuss important and study process related problems. The remarks and proposals of the students are recorded and forwarded to the FSPC, heads of Departments, and Faculty administration.

The information on the programme evaluation and accreditation is published and easily accessible on the website of KTU. The management staff of the Faculty receives information on evaluation, conclusions and recommendations during the meetings of their Departments and open meetings of FSPC. The main documents related to study quality issues are provided on the website of the KTU. However, the review team concluded there are some previous external evaluation recommendations which have not yet been realized, such as: increasing autonomous student work and self-learning components, using of e-learning platforms to develop discussion among students together with teachers.

2.7. Examples of excellence *

* if there are any to be shared as a good practice

Core definition: Excellence means exhibiting characteristics that are very good and, implicitly, not achievable by all.

Explanatory context Excellence enshrines one meaning of quality: a traditional view that associates quality with the exceptional

III. RECOMMENDATIONS*

1. After finishing the core subjects one can either choose more elective courses in this field, or (in case of double degree studies) choose a minor study field - these paths should be clearly described and distinguished at the level of skills, competences and learning outcomes.
2. Recommendations given by previous review team are only partially fulfilled: teaching/learning methods of basic mathematical courses are still classical ex-cathedra in most cases: stronger orientation to practical work (more group-based and project-based approach) should be encouraged in lectures and practices, more alternative ways of teaching should be introduced in everyday practice. In this regard, some classrooms should be arranged as workplaces for group works and examples should be chosen from application areas as motivation of students to be more interested in fundamental mathematics.
3. There is a need for efficient internalisation strategy to increase a number of incoming/outcoming students.
4. Relatively small percent of students participating in scientific research. Scientific work should be encouraged among students.
5. Participation of professors from foreign universities in the study courses could be increased.
6. In some cases the relationship with other faculties of KTU could be improved. This is important for the double degree programmes.
7. Internship need to be even closer to real-life applied mathematics and therefore is important to avoid internship inside the KTU.
8. Improved statistical methods should be used to evaluate the achieved improvement of the study programme (employability, number of enrolled foreign and domestic students, etc.) in order to establish a more convincing Quality Assurance system.

*If the programme is going to be given negative evaluation (non-accreditation) instead of RECOMMENDATIONS main **arguments for negative evaluation** (non-accreditation) must be provided together with a **list of “must do” actions** in order to assure that students admitted before programme’s non-accreditation will gain knowledge and skills at least on minimum level.

IV. SUMMARY

In terms of programme aims and learning outcomes, the European and Lithuanian higher education recommendations, standards and legal requirements are all fulfilled. Learning outcomes are clearly presented in the SER and online as well, and are assigned with courses. The needs analysis is convincing. As a minor weakness, the Expert Team observed, that after finishing the core subjects one can either choose more elective courses in this field, or (in case of double degree studies) choose a minor study field, but these paths are not clearly described at the level of skills, competences and learning outcomes.

In terms of Curriculum design the main strengths are the following: the programme structure corresponds the needs of law, the scope of Programme is sufficient to ensure the learning outcomes; possibility to form individual study programme by choosing elective courses (elective subjects for deeper specialization in the field or other field module(s) or course(s), or general university study course(s) is present, and description of study subjects is well designed. However recommendations given by previous review team are only partially fulfilled: teaching/learning methods of basic mathematical courses are classical ex- cathedra so far; they do not involve each week test and discussion of solution, as well as using software packages.

The academic staff is highly qualified and competent: the academic staff includes the high percentage of professors and associated professors; the lecturers are active in the research work and have published several scientific publications and performed some research projects. There are a good balance between older, middle-age and young researchers. Academic staff members participate in international conferences, research traineeships, international exchange programs. There have been organized of teacher training modules and intensive short courses in abroad. All lecturers' used the possibility to develop their professional qualification during the evaluation period. Teaching materials, including recorded lectures are available online. Teaching materials contain real-life problems and very application oriented view. Several lecturers do research together with the industrial and academic organizations in the regions.

As a weakness, the Expert Team observed that participation of professors from foreign universities in the study courses can be higher. In some cases the relationship with other faculties of KTU is not good. The programme have some space for future improvement of knowledges and teaching skills for teaching the subjects of this Program. Therefore longer period of stay abroad for teacher is needed.

In terms of facilities and learning resources overall well-equipped building and classrooms are present. Wide access of online scientific materials is available. However, some classroom should be arranged as workplaces for group works. Professional internship inside KTU should be allowed as an exception only.

In terms of study process and students' performance assessment strengths are the flexible and highly individualised studies: availability of minor studies and optional subjects, studies schedule harmonisation with students. Exceptionally good system of internships is present. The knowledge and abilities of students very well correspond to the expectations of employers, which causes a very high level of graduates' employment.

However, the mobility rate of students is low. There is a need for efficient internalisation strategy to increase a number of incoming/out coming students. As it has been recommended by the previous report, stronger orientation to practical work (more group-based and project-based approach) is missing in lectures and practices, more alternative ways of teaching should be introduced. Relatively small percent of students participating in scientific research.

In terms of programme management the implementation of various principles of KTU quality assurance of studies is of high quality. Graduates, members of Field Study Programme Committee, social partners and companies discussions with potential employers are also involved in studies' quality assurance and improvement process, which is a plus. Students take part at all level of Programme management and their opinion is appreciated. However, descriptive statistical methods are not used to evaluate achieved improvement of the study programme (employability, number of enrolled foreign and domestic students, etc.), which is a minor weakness.

V. GENERAL ASSESSMENT

The study programme Applied mathematics (state code – 612G10002) at Kaunas University of technology is given **positive** evaluation.

Study programme assessment in points by evaluation areas.

| No. | Evaluation Area | Evaluation of an area in points* |
|-----|--|----------------------------------|
| 1. | Programme aims and learning outcomes | 4 |
| 2. | Curriculum design | 3 |
| 3. | Teaching staff | 3 |
| 4. | Facilities and learning resources | 3 |
| 5. | Study process and students' performance assessment | 3 |
| 6. | Programme management | 3 |
| | Total: | 19 |

*1 (unsatisfactory) - there are essential shortcomings that must be eliminated;

2 (satisfactory) - meets the established minimum requirements, needs improvement;

3 (good) - the field develops systematically, has distinctive features;

4 (very good) - the field is exceptionally good.

| | |
|---------------------------------|-------------------------|
| Grupės vadovas: Team leader: | Prof. Miklos Hoffmann |
| Grupės nariai: Team members: | Prof. Neda Bokan |
| | Assoc. Prof. Ants Aasma |
| | Mr. Marijus Mikalauskas |
| | Mr. Henrikas Vaickus |

**KAUNO TECHNOLOGIJOS UNIVERSITETO PIRMOSIOS PAKOPOS STUDIJŲ PROGRAMOS
 TAIKOMOJI MATEMATIKA (VALSTYBINIS KODAS - 612G10002)
 2017-09-14 EKSPERTINIO VERTINIMO IŠVADŲ NR. SV4-190 IŠRAŠAS**

<...>

V. APIBENDRINAMASIS ĮVERTINIMAS

Kauno technologijos universiteto studijų programa *Taikomoji matematika* (valstybinis kodas – 612G10002) vertinama **teigiamai**.

| Eil. Nr. | Vertinimo sritis | Srities įvertinimas, balais* |
|-----------------|--|-------------------------------------|
| 1. | Programos tikslai ir numatomi studijų rezultatai | 4 |
| 2. | Programos sandara | 3 |
| 3. | Personalas | 3 |
| 4. | Materialieji ištekliai | 3 |
| 5. | Studijų eiga ir jos vertinimas | 3 |
| 6. | Programos vadyba | 3 |
| | Iš viso: | 19 |

*1 - Nepatenkinamai (yra esminių trūkumų, kuriuos būtina pašalinti)

2 - Patenkinamai (tenkina minimalius reikalavimus, reikia tobulinti)

3 - Gerai (sistemiškai plėtojama sritis, turi savitų bruožų)

4 - Labai gerai (sritis yra išskirtinė)

<...>

IV. SANTRAUKA

Vertinant programos tikslus ir studijų rezultatus, Europos ir Lietuvos rekomendacijos, standartai ir teisiniai reikalavimai aukštajam mokslui įvykdyti. Studijų rezultatai aiškiai pateikiami SS ir internete, priskirti dalykams. Poreikių analizė įtikinanti. Kaip nedidelį trūkumą ekspertų grupė pastebėjo, kad baigę privalomuosius dalykus studentai gali rinktis daugiau tos pačios krypties pasirenkamųjų dalykų arba (jei pasirinktos dvigubo laipsnio studijos) rinktis gretutinę studijų kryptį, bet nėra aiškiai apibrėžti šių pasirinkimų siūlomi įgūdžiai, kompetencijos ir studijų rezultatai.

Programos sandaros pagrindinės stipriosios pusės yra šios: programos struktūra atitinka įstatymų reikalavimus, programos apimtis pakankama studijų rezultatams pasiekti, siūloma galimybė sudaryti individualią studijų programą iš pasirenkamųjų modulių (t. y. pasirenkamųjų dalykų, skirtų gilinti specializaciją studijų kryptyje arba kitos studijų krypties modulyje (-iuose) ar dalyke (-uose)) arba bendrų universiteto siūlomų modulių. Studijų dalykai gerai aprašyti. Nepaisant to, ankstesnės ekspertų grupės pateiktos rekomendacijos įvykdytos tik iš dalies: pagrindiniuose matematikos dalykuose vis dar naudojami klasikiniai pasyvūs dėstymo ir studijavimo metodai, į kuriuos neįeina savaitiniai testai ir sprendimų aptarimas ar programinės įrangos paketų naudojimas.

Akademinis personalas turi aukšto lygio kvalifikacijas ir yra kompetentingas: didelę jo dalį sudaro profesoriai ir docentai, dėstytojai aktyviai dalyvauja mokslinių tyrimų veikloje, yra išleidę keletą mokslinių publikacijų ir atlikę keletą mokslinių tyrimų projektų. Vyresnių, vidutinio amžiaus ir jaunų mokslininkų santykis yra geras. Akademinis personalas dalyvauja tarptautinėse konferencijose, mokslinių tyrimų stažuotėse, tarptautinėse mainų programose. Yra organizuojami mokytojų rengimo moduliai ir intensyvūs trumpieji mokymai užsienyje. Vertinimo laikotarpiu visi dėstytojai pasinaudojo galimybe tobulinti savo profesinę kvalifikaciją. Metodiniai ištekliai, taip pat ir paskaitų įrašai, pateikiami internete. Juose pateikiamos realios problemos, puikiai skatinančios praktinį taikymą. Kai kurie dėstytojai atlieka tyrimus kartu su pramonės ir akademinėmis organizacijomis regione.

Kaip silpnybę ekspertų grupė išskyrė tai, kad dėstant studijų dalykus galėtų dalyvauti daugiau profesorių iš užsienio universitetų. Kai kur trūksta gerų santykių su kitais KTU fakultetais. Yra kur tobulinti žinias ir dėstymo įgūdžius, reikalingus programos dalykams dėstyti. Dėstytojams reikėtų daugiau laiko praleisti užsienyje.

Vertinant materialiuosius išteklius, pastatai ir klasės apskritai gerai įrengti. Suteikiama plati prieiga prie mokslinės medžiagos internete. Tačiau kai kurias klases reikėtų pertvarkyti į darbo vietas grupiniam darbui. Profesinė praktika KTU turėtų būti leidžiama tik išimtiniais atvejais.

Studijų eigos ir studentų pasiekimų vertinimo stipriosios pusės yra studijų lankstumas ir galimybė didelę studijų dalį individualizuoti renkantis iš gretutinių studijų ir pasirenkamųjų dalykų, derinant studijų grafiką. Egzistuoja itin gera praktikos sistema. Studentų žinios ir gebėjimai labai gerai atitinka darbdavių lūkesčius, todėl labai aukštas absolventų įsidarbinimo rodiklis.

Tačiau žemas studentų judumo rodiklis. Reikalinga veiksminga internalizacijos strategija, kad būtų padidintas atvykstančių ir išvykstančių studentų skaičius. Kaip jau rekomenduota ankstesnėje ataskaitoje, per paskaitas ir praktiką daugiau dėmesio turėtų būti skiriama praktiniam (labiau grupiniam ir projektiniam) darbui, reikėtų numatyti daugiau alternatyvių dėstymo būdų. Santykinai mažas procentas studentų, dalyvaujančių moksliniuose tyrimuose.

Programos vadybos požiūriu labai gerai įgyvendinami įvairūs KTU studijų kokybės užtikrinimo principai. Dar vienas plusas – į studijų kokybės užtikrinimo ir tobulinimo procesą taip pat įtrauktos diskusijos tarp absolventų, krypties studijų programos komiteto narių, socialinių dalininkų, įmonių ir potencialių darbdavių. Studentai dalyvauja visuose programos vadybos lygmenyse ir jų nuomonė vertinama. Nepaisant to, vertinant studijų programos pagerėjimus (įsidarbinimo galimybes, įstojusią užsienio ir šalies studentų skaičių, t. t.), trūksta apibūdinamųjų statistinių metodų, o tai šioks toks trūkumas.

<...>

III. REKOMENDACIJOS

1. Baigę privalomuosius dalykus, studentai gali rinktis daugiau tos pačios krypties pasirenkamųjų dalykų arba (jei pasirinktos dvigubo laipsnio studijos) rinktis gretutinę studijų kryptį – šiuos pasirinkimus reikėtų aiškiai apibrėžti ir išskirti jų siūlomus įgūdžius, kompetencijas ir studijų rezultatus.
2. Ankstesnės ekspertų grupės pateiktos rekomendacijos buvo įvykdytos tik iš dalies: pagrindiniuose matematikos dalykuose dažnai vis dar naudojami klasikiniai pasyvūs dėstymo ir studijavimo metodai, paskaitose daugiau dėmesio turėtų būti skiriama praktiniam (labiau grupiniam ir projektiniam) darbui, kasdienėje praktikoje reikėtų naudoti daugiau alternatyvių dėstymo būdų. Šiam tikslui reikėtų kai kurias klases pertvarkyti į darbo vietas grupiniam darbui, taip pat parinkti pavyzdžių iš taikymo sričių, tokiu būdu skatinant studentus labiau domėtis pagrindine matematika.

3. Reikalinga veiksminga internalizacijos strategija, kad būtų padidintas atvykstančių ir išvykstančių studentų skaičius.
4. Santykinai mažas procentas studentų, dalyvaujančių moksliniuose tyrimuose. Reikėtų skatinti studentų mokslinius darbus.
5. Reikėtų padidinti iš užsienio universitetų atvykstančių profesorių, kurie dėstytų studijų dalykus, skaičių.
6. Kai kuriais atvejais galima būtų pagerinti santykius su kitais KTU fakultetais. Tai svarbu dvigubo laipsnio programoms.
7. Praktika turi dar tiksliau atitikti darbo rinkoje naudojamą taikomąją matematiką, todėl svarbu vengti praktikos pačiame KTU.
8. Vertinant studijų programos pagerėjimą (įsidarbinimo galimybes, įstojusių užsienio ir šalies studentų skaičių, t. t.), reikėtų naudoti geresnius statistinius metodus, kad būtų sukurta patikimesnė kokybės užtikrinimo sistema.

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