CENTER FOR QUALITY ASSESSMENT IN HIGHER EDUCATION

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OVERVIEW REPORT FOR MECHANICAL ENGINEERING STUDY FIELD

2020 Year of the evaluation

Prepared by the chairperson of the expert panel

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Report language – English

Vilnius
2021

I. INTRODUCTION

This report is based on the external quality evaluation of the Mechanical Engineering study field in Lithuanian Higher Education Institutions*:* at *Kaunas University of Technology (KTU); at Klaipeda University (KU); at Vilnius Gediminas Technical University (VGTU); at Vytautas Magnus University (VMU); at Klaipeda State College (KVK); at University of Applied Engineering Sciences in Kaunas (KTK); at Vilnius College of Technologies and Design (VDTK).*

The external evaluations were organised by the Lithuanian Centre for Quality Assessment in Higher Education (SKVC).

Comprehensive external evaluation reports including strengths and weaknesses and concluding with some recommendations were prepared for the Mechanical Engineering study field in each evaluated Higher education institution (separately for first and second cycle) and included evaluation marks. This overview focuses on the main findings of the external evaluation of the Mechanical Engineering study field from a general point of view.

Based on the findings of Mechanical Engineering study field evaluation, expert panel have come to a decision to give **positive** evaluation to HEIs: at *Kaunas University of Technology, first cycle; at Kaunas University of Technology, second cycle:* at *Klaipeda University, first cycle; ; at Vilnius Gediminas Technical University, first cycle; at Vilnius Gediminas Technical University, second cycle; at Vytautas Magnus University, first cycle; at Vytautas Magnus University, second cycle; at Klaipeda State College, first cycle; at University of Applied Engineering Sciences in Kaunas, first cycle; at Vilnius College of Technologies and Design, first cycle.*

On the basis of external evaluation report of the study field SKVC takes a decision to accredit study field either for 7 years or for 3 years. If the field evaluation is negative such study field is not accredited.

II. STUDY FIELD OVERVIEW BY EVALUATION AREAS

2.1. STUDY AIMS, OUTCOMES AND CONTENT

The evaluation team found that the aims, learning outcomes and contents of the study programmes in Mechanical Engineering (hereafter – ME) at both first cycle and second cycle in the Higher Education Institutions (HEI) which were evaluated are generally well founded and at the appropriate level in the sense that they address scientific and practical as well as professional engineering knowledge, skills and attitudes demanded by the industry in Lithuania as well as in the EU. However, there is room for improvement in certain areas: for example, while most of the learning outcomes conform with the EUR-ACE framework for the accreditation of engineering studies, some of them don't, particularly at subject level. Also, all learning outcomes should be expressed in active terms i.e. what the graduate is able to do on completion of the study programme, so expressions such as 'knows', 'understands', 'is aware of', etc., should be avoided. The study subject learning outcomes should also be harmonised with the study programme learning outcomes.

The curricula of the study programmes should be constantly reviewed to ensure that the latest developments in the industry are included (e.g., Smart Industry, Additive Manufacturing, new programming languages such as Python, etc.). In certain cases, a review of the curriculum has been suggested to include some fundamental topics such as programming, thermodynamic cycles, welding, etc. The involvement of the social partners in

the Study Programme Committee and the Final theses assessment should enable the latest developments to be introduced into the programmes.

Most of the final theses at the first cycle address problems in the local industry which is commendable but care should be taken to ensure that some degree of innovation is included in these projects. Research-based projects should also be encouraged for those students who may wish to pursue a research career. The second cycle theses are in some cases linked to on-going research in the institution or solution of advanced industrial problems and are generally of appropriate level.

3.2. LINKS BETWEEN SCIENCE (ART) AND STUDY ACTIVITIES

There is evidence that teachers in the Mechanical Engineering study field are actively engaged in scientific research and development directly related to the content of the study programmes. The quality of research varies from international standard, in-depth scientific research to applied research focusing on industrial problems of social partners. However, in general, the quality and quantity of publications is rather low for the number of staff. There seems a tendency to publish in local and national scientific journals rather than in international scientific journals with high impact factors. Teachers should be encouraged and supported to publish in international journals with high impact factors so as to raise the profile of teachers and their universities.

Research is generally integrated into the second cycle studies while first cycle students may get involved in research and development activities through semester projects and individual final degree projects. Final thesis projects at the second cycle generally involve the solution of advanced problems of industrial partners or ongoing research in the institution. There is also evidence that results of research projects are integrated into some study subjects. The ME subjects taught in the second cycle are at an advanced level and in specializations related to latest industrial practices and are taught by teachers who are active in research in the areas of specialization. Different specializations are available in the different institutions – for example KTU specializes in Biomechanics and Microelectromechanical Systems, while VMU specializes in Agricultural Mechanical Engineering and KTK in Materials Processing etc. This is good as it should enable each institution to have enough researchers in their areas of specialization to achieve critical mass and make a greater impact.

Ability to pursue leading edge research depends on funding obtained from industrial, national and international funding bodies. There is evidence that social partners are willing to provide funding for applied research and all the institutions are involved in this type of research. However, there is less evidence of involvement in national and international scientific research projects such as those financed by the Research Council of Lithuania and EU Horizon. KTU seems to be particularly successful in obtaining scientific research funding from both national and international funding bodies with 4 EU funded projects (H2020 and M-ERA.NET), various European cooperation projects and a large number of research projects funded at national level. However, there are other successes: KU's participation in the Erasmus+ project 'European University for Sustainable Development of Smart Cities' and Horizon 2020 CONEXUS SWAFS project which is dedicated to the qualitative transformation of EU CONEXUS research activities with a share of 0.5 million Euros, enabling joint research groups to be formed with business and industry in the region; VMU's R&D projects and doctoral scholarships funded by Research Council Lithuania and one EU funded research project (ERA-NET); VGTU with several national and international research projects etc. Nevertheless, the teachers should be encouraged and supported to apply for more research projects funded by national and international bodies.

3.3. STUDENT ADMISSION AND SUPPORT

Admissions to the first cycle ME programmes by Lithuanian nationals seems to be declining in recent years. This is partly attributed to the declining number of high school students due to the demographic situation in Lithuania. KTU is maintaining a stable number of admitted students at around 70 which is very healthy but this is due to an increasing number of international students. At VTDK, the number of admissions was stable at around 50 until 2018 but dropped to 31 in 2019. For KU, VMU and KTK the number of admitted students has dropped to around 10 to 12. For KVK, the number of admissions was 32 in 2017, 30 in 2018 but no admissions in 2019. It is therefore clear that some of these programmes may become unsustainable unless more students can be recruited. KTU has shown that the way to compensate for the declining number of Lithuanian nationals is to recruit international students. However, this requires that full information about the programmes is available on the institution's website in English language and that the programmes be delivered in English language. Expert panel notes that most of the other institutions' websites do not provide comprehensive information about the study programme in English language and are also difficult to navigate. Therefore, in order to attract international students, expert panel recommends that the English versions of the websites should be improved to be more attractive and to provide comprehensive information. Expert panel also notes that there are very few female students on the ME programmes. Great effort should be made to attract female students through better promotion of the programmes.

For the second cycle ME programmes, the numbers of students admitted have been quite stable – around 11 at VMU, 12 to 24 at VGTU and between 10 and 25 at KTU, including international students. Again, KTU seems much more able to attract international students. KTU currently offers the second cycle programme in both Lithuanian and English. This means international students are often taught separately from Lithuanian students. This is wasteful, especially for the numbers concerned and does not promote the internationalisation which would occur if all the students attend classes together and do group projects together. A more efficient approach would be to offer the second cycle programmes exclusively in English which would also promote internationalisation. VGTU and VMU could also adopt this approach to attract more international students and promote internationalisation. It would also attract more incoming Erasmus+ students.

All institutions have adopted a fair procedure for recognition of foreign qualifications, partial studies and prior non-formal and informal learning. This makes it easy to recognise credits from other universities and hence promote student mobility. Nevertheless, even though all the institutions promote mobility programmes and provide support, very few students opt to take up the opportunities provided. Students are also provided with adequate academic, financial, social and psychological support. Sufficient study information and study support is provided by the teachers through student counselling sessions which can be booked by the students. There is also a lot of informal support due to the small number of students.

The dropout rate for students in the ME study field is generally high. In the first study cycle only around 60% of students are graduating on schedule. For the second cycle about 70% of students graduate on schedule. However, students are able to take a break from studies and resume their studies later.

3.4. STUDYING, STUDENT PERFORMANCE AND GRADUATE EMPLOYMENT

ME study programmes in all the institutions have adopted teaching, learning and assessment methods which are able to deliver the learning outcomes e.g., individual and group project work, study visits, laboratory work, discussions, problem-solving sessions, case studies, etc. They are all actively encouraging their staff to improve their didactic, digital and language

competences by participating in professional development courses. For example, KTU has a unit for didactics which provides support to teachers regarding subject structure, learning outcomes, teaching activities and assessments, etc. VMU and VGTU also have similar units and other institutions' teachers can attend courses offered by these units.

Institutions are adapting their buildings and other facilities for accessibility to students with special needs and all new buildings are designed to enable easy access for people with mobility issues. Library departments also provide readers with individual needs with access to special software, equipment, keyboards etc to enable visually impaired people to access the information they need.

All institutions have an Academic Information System (AIS) which enables students to monitor their progress so that they can take action to improve their performance. The virtual learning environment Moodle is also used by all the institutions and students are provided with feedback on their assignments using this system. Students interviewed were happy about the quality of feedback and the speed with which it is provided. They also confirmed that they receive informal feedback from the teachers.

There are established and transparent procedures for ensuring academic integrity and codes of ethics. Students also have the right to appeal against assessment results or raise complaints regarding the study process using established procedures which are defined in the study regulations.

Data for monitoring the career of graduates are collected in different ways including official government statistics and through alumni surveys. Graduates of both the first cycle and second cycle tend to find employment soon after graduating. Indeed, many of them are already employed before they complete their studies and there is a shortage of graduates of the field of Mechanical Engineering in Lithuania. A large proportion of the graduates also progress to senior positions in their companies within a couple of years after graduating. A good proportion of the first cycle graduates continue their studies in the second cycle programmes while some of the second cycle graduates go on to pursue doctoral studies especially at KTU, VGTU and VMU which will provide the teaching staff in the future.

3.5. TEACHING STAFF

All the institutions in the ME field of studies have sufficient numbers of well qualified and experienced teachers to satisfy the legal requirements. The age distribution is quite good with the majority of the teachers in the middle age group. There are also some young lecturers who have recently started their careers, as well as doctoral students who will be able to replace those teachers who are close to retirement. Most of the teachers have written text books and are involved in research and participate regularly in international scientific conferences. Much of the research carried out is applied research in cooperation with social partners and supervision of final thesis projects related to problems of industries. This provides them with engineering practice which enriches their teaching.

All institutions provide good conditions for teachers to participate in academic mobility programmes but in most institutions insufficient number of teachers make use of this opportunity. However, there is very good participation in professional development courses to develop didactic, digital and language competences. If teachers continue to fail to take advantage of the opportunities for academic mobility it may be necessary to make it compulsory for every teacher to participate in such programmes at least once every five years.

3.6. LEARNING FACILITIES AND RESOURCES

All the institutions in the ME field of studies have upgraded their learning facilities in the last few years. The lecture theatres and rooms are adequately equipped for lecture delivery with a variety of capacities to accommodate the number of students in each study subject. Laboratories and workshops are well equipped for the study of Mechanical Engineering. Computer equipment (hardware and software) are adequate and up-to-date in quantity and quality and both students and teachers have access to a virtual learning environment and collaboration systems – Microsoft Teams and Moodle which provide tools for teamwork. The libraries are well stocked with text books as well as up-to-date journals. Access is provided to electronic resources (e-books, e-journals, e-conference materials, etc.) and the libraries subscribe to scientific journals and bibliographic databases such as Sage Journals Online, Sage IMechE Journals, ScienceDirect, SpringerLink, Taylor Francis, Wiley Online, etc.

Most of the institutions have upgraded their facilities by using grants obtained from European and national bodies. In some cases, social partners have provided equipment or assisted in acquiring modern equipment for the laboratories and workshops (e.g., VMU, KTK). The result is that all the institutions now have well-equipped modern laboratories and workshops which are adequate for teaching and research. KTU is currently establishing an interdisciplinary innovation and testing laboratory, M-Lab, which will be an area for research, innovation, knowledge sharing and education. According to descriptions of the layout, M-Lab will be on par with the innovation laboratories of world-leading engineering schools.

Generally, the processes of updating computers, multimedia equipment and information resources are well established. However, the cost of updating laboratory equipment can be very high so institutions must continue to provide adequate budgets for this purpose. Research grants and other project grants can provide funds for new equipment so it is important that institutions continue to encourage and support applications for research and development grants by the teachers, particularly EU grants.

3.7. STUDY QUALITY MANAGEMENT AND PUBLICITY

Each institution has developed its own system for the management of study programmes. Generally, the Study Programme Committee (SPC) has the major responsibility for development, quality assurance and execution of the study programmes. The SPC is responsible for compiling and analysing study quality indicators (study performance statistics, student feedback questionnaires, surveys of stakeholders, etc.). These indicators are then used to take decisions at various levels (SPC, Department, Faculty, Academic Council). Most of the decisions are taken at SPC level with approval by the head of department and sometimes by Dean of faculty so decision paths are generally quite short. Teachers are aware of the quality assurance system and take the students' feedback seriously and use it to improve their teaching. It appears that the study quality management systems used by the different institutions are well founded and KU has even obtained ISO 9001certification for its system. Nevertheless, it is recommended that a periodic internal audit of the quality assurance system is carried out and exceptions noted for remediation.

Systems are put in place to collect feedback from stakeholders using surveys, interviews, roundtable discussions, etc. A major source of feedback is the questionnaires on study modules and lectures completed anonymously by students at the end of the autumn and spring semesters. These along with the views of social partners, teachers and alumni are considered by the SPC to determine actions that need to be taken to improve the programme and subjects. Students, teachers and social partners, in interviews, confirmed that the systems work very well. In some institutions, the information on studies, their evaluation and outcomes are published on the university website (e.g., KTU) but this is not general practice.

Open publication of information on studies is recommended by the evaluation team as it provides information not only to the stakeholders but also to prospective students.

III. EXAMPLES OF EXCELLENCE

- At VGTU, Second Cycle students are encouraged to participate, annually, in the "Conference for Young Scientists of Lithuania “Science – the Future of Lithuania” Conference organized by the University, in which students from different disciplines participate. This enables them to develop additional skills and competences especially in the field of research and innovation. Also, all second cycle students of VMU must publish their research results in scientific papers either at a scientific conference or in a scientific journal.
- Some very interesting interdisciplinary student projects are carried out at both VDTK and KVK. These projects are extremely beneficial for the study programme students, as they provide a platform for practical application of the knowledge acquired and some hand on experience. Moreover, cooperation with students from other study fields represents the additional dimension, which is beneficial to all the students participating.
- Mechanical Engineering students of KU participate, annually, in the "International Aventics Pneumobile” competition in Hungary, in which they have won many prizes. Likewise VTDK students participate in the National Mechatronics competition and “Best Materials Processing Engineer” competition in Hungary. These competitions enable them to develop additional skills and competences as well as international connections.
- The KTU website is excellent. General information about the university, education, admissions as well as specific information about programmes and subjects are easily accessible, complete and informative.
- The management structure with short decision paths, clear responsibilities and the strong programme level committee at all institutions is admirable. The management structure is able to handle change (top-down as well as bottom-up) efficiently. This includes also implementation, evaluation and refinement of changes.
- At KTU, the student learning-oriented environment including laboratories and workshops as well as digital tools are excellent facilities with up-to-date adequate equipment. The possibilities with the new M-lab will further strengthen this to become a benchmark for progressive Mechanical Engineering education.
- All the institutions maintain close and mutually beneficial relations with the Lithuanian industry which is admirable. This allows the knowledge, skills and attitudes of the graduates to perfectly match the needs of the industry and the graduates to quickly find relevant job positions.

IV. RECOMMENDATIONS

MAIN STRATEGIC RECOMMENDATIONS FOR THE IMPROVEMENT IN NNN STUDY FIELD

➢ Strategic recommendations at institutional level (for Higher Education Institutions):

Mechanical engineers are critical to the manufacturing industry and, thus, to the Lithuanian economy. Consequently, there is a close relation between the Lithuanian manufacturing industry and The Higher Education Institutes (HEIs) offering study programmes within the field of Mechanical Engineering (ME). As a result of this, the knowledge, skills and attitudes of the ME graduates perfectly match the needs of the industry today. However, keeping pace with technological developments made possible by the rapid digitalisation and the exploration of new materials, the industry needs to embrace forward thinking engineers. The HEIs then need to educate those engineers. The core of Mechanical engineering will always have an underlying importance but to meet future needs and to stay relevant the ME study programmes need to introduce advanced courses in emerging technologies and materials such as, e.g., AI, embedded systems, smart manufacturing, smart mobility, nanotechnology and renewable energy. The evaluation team has observed some promising initiatives in this direction, but it needs to become more widespread and have a greater impact on students' choices. The study programmes have specialisations in which the students develop their disciplinary knowledge. For the students to develop collaborative, innovative and interdisciplinary skills, the HEIs should offer interdisciplinary modules open for students from different study programmes and disciplines.

As a result of globalization mechanical engineers work and collaborate closely with colleagues from diverse cultural backgrounds. Hence, ME graduates need to be able to easily cross national, cultural and language barriers to function efficiently in global engineering teams. International exchange programs have traditionally been an effective tool to provide students with global experiences. However, despite the favourable conditions for studying abroad offered by HEIs, these possibilities have not been widely embraced by the Lithuanian ME students. Of course, the HEIs will continue to market the opportunities to study or do internships abroad. But they should also better take advantage of the fact that they have a relatively large number of international students in their ME study field programmes. The evaluation team recommends the HEIs to teach the second cycle study programmes only and entirely in English. In addition, in first level study programmes, a few courses may be taught entirely in English. This will create good opportunities for the students to develop skills in intercultural collaboration and communications.

The number and fraction of female students in the Lithuanian ME study field programmes are generally very low and lower compared to many similar programmes in the rest of Europe. Without achieving young people’s demand of a critical mass of diverse talents and experiences, the relevance of the ME study field programmes as well as the ME industry can be questioned. Furthermore, as there is a great need for more ME engineers in the Lithuanian industry and the fact that the HEIs can enrol many more students in their ME study field programmes, the HEIs should make joint targeted recruitment efforts together with the industry and also put significant efforts to increase the attractiveness of the ME profession to women. A favourable condition compared to similar HEIs in the rest of Europe is that there is a good number of female lecturers and professors at the HEIs that can be used as role models for young girls.

All HEIs have successfully transferred to distance and on-line teaching due to the Covid 19 pandemic. Most things have gone very well and the HEIs have taken a significant step towards

blended learning which may have taken five years under normal conditions. Engineering studies are naturally largely campus-based, but it is important that there is no return to "the old" when the pandemic is over. The evaluation team recommends the HEIs to continue the development and the quality enhancement of education by applying active learning and on-line teaching as alternatives to traditional classroom lecturing. Typically, the on-line part can consist of structured preparation with videos on theoretical derivations and problem solving, reading materials and quizzes before the students and teachers meet face-to-face in the classroom. The activities in the classroom typically include discussions, tutoring, preparation for assignments, projects, labs and teamwork.

- **Strategic recommendations at national level (for the Ministry of Education and Science):**

The evaluation process has been well organized by SKVC. The Higher Education Institutions (HEIs) have been very well prepared and organized the virtual visits well and been sensitive to the evaluation team's wishes. The virtual format has worked, but it has also meant difficulties for the evaluation team to interpret nuances and ask deeper questions during interviews and to critically review the facilities. Information on web pages has to some extent replaced impressions from site visits and face-to-face meetings. Not all HEIs had all needed information available in English on their webpages which made the investigations somewhat more difficult. In future evaluations, when the conditions allow, the evaluation team recommends a return to physical on-site visits but with the possibilities of digital meetings as well.

Overall, the evaluation team finds the evaluation methodology meaningful and potentially very valuable for the Higher Education Institutions (HEIs). In addition to the formal accreditation issue, the methodology also delivers valuable recommendations and advice. It is also very clear that the HEIs have taken criticism, recommendations and advice from previous evaluations very seriously and carefully implemented it to an impressive extent according to a continuous improvement philosophy. This is also particularly encouraging for the evaluation team whose efforts then feel worthwhile. With this said the evaluation team concludes that the study programmes in the field of Mechanical Engineering have satisfactory or higher quality with respect to all areas of the evaluation. The outcomes of the study programmes match very well the demands from Lithuanian industry oriented towards product development, manufacturing and production. There is no unemployment among graduates from the study field of Mechanical Engineering and the needs of the industry appear to be growing steadily over the next five to ten years. But the industry is transforming very fast through the extensive electrification and digitization that, e.g., is manifested in Industry 4.0 (The Fourth Industrial Revolution) with its rapidly ongoing automation of traditional manufacturing and industrial practices. This means that the study programmes within the field of Mechanical Engineering need to be developing rapidly to maintain their relevance. In view of this, an accreditation period of 7 years seems to be a little bit too long. On the other hand, the HEIs have internal quality systems in place that should be able to handle this transformation. However, the evaluation team will still point this out as a possible risk.

The evaluation methodology of external evaluation of study fields itself is fine and serves its purposes very well. The different areas of evaluation are all relevant and complete. Nevertheless, the evaluation team found that Evaluation area 4, "Studying, student performance and graduate employment" was difficult to give a uniform assessment as it combines different aspects. Graduate employment does not fit together with studying and student performance as, e.g., from interviews with students from one HEI it was clear that studying conditions were not excellent (but satisfactory) while the graduate employment rate

was excellent. Thus, the evaluation team recommends Evaluation area 4 to be split into two different areas or return to the previous system with six areas. To facilitate the production of evaluation reports and self-evaluation reports, it would be advantageous to have fewer subcategories under each area of evaluation. The evaluation team finds some of the subcategories to be overlapping which is also manifested in the self-evaluation reports. For example, Evaluation area 2 “Links between science (art) and study activities” may be more concisely assessed without being divided into three subcategories, the same holds for Evaluation area 6 “Learning facilities and resources”, and for the sake of clarity, it may be advantageous to merge subcategories 3.4 “Assessment of the suitability, adequacy and effectiveness of the academic, financial, social, psychological and personal support provided to the students of the field.” and 3.5 “Evaluation of the sufficiency of study information and student counselling”. Thus, to narrow the report lengths slightly and get more concise reports, it is recommended to reduce the number of subcategories.