FINNISH EDUCATION EVALUATION CENTRE

ACCREDITATION OF THE DEGREE PROGRAMME IN MECHANICAL ENGINEERING AT JAMK UNIVERSITY OF APPLIED SCIENCES

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Description of the accreditation process and of the degree programme

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1.1 Aim of the accreditation

The aim of FINEEC's Engineering Programme Accreditations is to support the enhancement of quality in engineering degree programmes and to provide higher education institutions with the means of deciding whether an engineering degree programme provides its graduates with the academic qualifications necessary for a career in the engineering profession. The accreditation assesses the way an engineering degree programme is planned, delivered and developed to ensure that the students reach the programme outcomes and how the programme outcomes align with the reference programme outcomes set in the FINEEC Engineering Programme Accreditations manual. The reference programme outcomes describe the knowledge, skills and competencies that engineering students should have acquired by the time they have completed a degree programme in engineering. The accreditation evaluates the extent to which the set standards for programme's planning, implementation, resources and quality management are met.

1.2 Degree programme in Mechanical Engineering

The Degree Programme in Mechanical Engineering belongs to the JAMK University of Applied Sciences. JAMK UAS is located in Central Finland, having a main campus in Jyväskylä. The Degree Programme leads to a Bachelor of Engineering degree. Language of instruction is Finnish. The degree programme consists of 240 ECTS and intended study time for full-time studies is 4 years. Yearly intake is 40 students, including full-time and part-time students. Both full-time studies and part-time studies follow the same curriculum. The degree programme has a double degree contract with Esslingen UAS in Germany. Students joining the double degree implementation are selected separately from the student body in the course of the studies.

The degree programme has two specialisation areas as follows:

- Product Development
- Production Engineering

1.3 The accreditation process

The accreditation was conducted in accordance with the principles set in the *FINEEC standards and procedures for engineering programme accreditation* document. The schedule of the accreditation was the following:

1. The accreditation team was appointed by the FINEEC Committee for Engineering Education on 19TH February 2021.
2. JAMK University of Applied Sciences submitted the self-evaluation report on 28th February 2021.
3. An online visit to the degree programme was conducted on 30–31 March 2021. The programme of the visit is given in table 1. The online visit was carried out by using Teams software.
4. Decision making meeting of FINEEC Committee for Engineering Education on 24th May 2021.

TABLE 1. Online visit programme

Online visit programme			
Tuesday 30th March 2021		***Wednesday 31st March 2021***	
9.00–10.00	Presentation on the electronic evidence room (a Moodle workspace) for the accreditation team	09.00–09.50	Interview with the external stakeholders
10.15–11.15	Interview with the JAMK UAS and the degree programme management	10.05–10.55	Interview with the students
11.30–12.20	Interview with the academic staff	11.10–12.00	Interview with the alumni of the degree programme
13.20–14.10	Interview with the support services staff	13.00–14.30	Academic staff presented examples on the teaching and assessment methods (demos)
14.25–15.25	Questions on the recorded facilities tour directed to the degree programme staff, in particular laboratory engineers and project engineers	14.30–16.30	Accreditation team meeting: discussion on the initial findings and preparation of the initial feedback
15.40–17.00	Accreditation team worked together in the electronic evidence room (a Moodle workspace)	16.45–17.30	Initial feedback for the JAMK UAS and the degree programme

1.4 The accreditation team

Chair of the accreditation team:
Professor **Silvia Schintke**, University of Applied Sciences and Arts Western Switzerland (Switzerland)

Team members:
Consultant **Leena Mattila**, ExcRes Oy (Finland)
Senior Lecturer **Pekka Salonen**, Metropolia University of Applied Sciences (Finland)
Master´s programme student **Carsten Schiffer**, RWTH Aachen University (Germany)

Senior Evaluation Advisor **Kati Isoaho** from FINEEC acted as a Project Manager for the accreditation process.

1.5 Evidence used in the accreditation

Self-evaluation report, along with the following appendices:

- List of Advisory board of Degree Programme in Mechanical Engineering.
- Last four memos of the Advisory Board meetings.
- Future competencies-Work Shop-Production-results.
- Future competencies-Work Shop-Product development-results.
- Memo of Mechanical engineering team meeting 5.12.2015: Corrective actions after year 2015 EUR-ACE accreditation.
- D3.4.6_Feedback Survey of the First Round Projects Final Version.
- Personal learning agreement and transcript of records XXX-DD-student TKN18 29.10.2020.
- Year after graduation placement follow-up summary.
- Key Figures of the programme.
- Grade distribution TKN17S1.
- JAMK Common competences vs. EUR-ACE-Reference programme learning outcomes.
- Department staff description.
- RDI Projects Mechanical Engineering.
- Publications Mechanical Engineering 2015–2021.
- Co-operation HEIs of Mechanical Engineering.
- Example of mid-course feedback and analysis.

- Accreditation team had access to the JAMK UAS staff intranet (including Moodle and Optima learning platforms) during the review process.
- Information gathered during the online visit within the interviews with the JAMK UAS and the degree programme management, academic staff, support services staff, current students, alumni as well as key stakeholders.
- The recorded video tour on JAMK UAS and the degree programme facilities, focusing on the laboratory premises.
- Evidence gathered by the degree programme for the electronic evidence room, which included course material, thesis works, project works and examples of course feedback, among other things. The evidence room was arranged as a Moodle software workspace. The accreditation team had access to the evidence room starting from the 29th of March 2021 during the review process.

2

Evaluation of the fulfilment of the accreditation standards

2

2.1 Planning of the programme

Standard 1: The programme aims, which describe the educational task and purpose of the programme, are consistent with the mission of the higher education institution and reflect the identified needs of employers and other stakeholders.

The Mechanical Engineering degree programme at JAMK aims at training students for two specialisation options, which are Product Development and Production Technology. Both options are strongly oriented towards the needs of companies from the region of Central Finland. The degree programme aims are clearly identified and updated on a regular basis. The close collaboration with industrial stakeholder groups is highly convincing. The degree programme demonstrates this in particular through regular meetings with its very active Advisory Board, which includes several important big companies from the region of Central Finland and representative of the City of Jyväskylä.

Major industrial stakeholders are thus directly involved in the development of the degree programme aims. Public stakeholders, such as the City of Jyväskylä are consulted at the level of the UAS and the School of Technology with regard to institutional focus area definitions. JAMK has defined six focus areas in its strategy: Bioeconomy, Education Expertise and Business, Tourism, Automation and Robotics (Rising/Emerging Industries), Multidisciplinary Rehabilitation, and Applied Cybersecurity. According to the self-evaluation report, new digitalisation, cybersecurity and especially automation and robotics technologies will be tightly connected to the general design and production methods of mechanical engineering. A main focus in the Jyväskylä area is on manufacturing industries. The degree programme is coherently oriented to the JAMK focus area of Automation and Robotics and aims for the future towards the integration of topics which are relevant to Industry 5.0.

Smaller companies are also indirectly involved, e.g. through feedback from graduate thesis projects, as well as by consulting alumni. Furthermore, over the last years the degree programme has increased its course offers on entrepreneurship, which especially helps

to also take into account the needs that are encountered by smaller companies. This also contributes to favouring possible start-up creation. This aspect could be further developed in particular for the Product Development specialisation.

In addition to the Advisory Board, the degree programme utilises the information gained from the student feedback as well as project and RDI cooperation when developing the degree programme aims. Furthermore, according to the self-evaluation the degree programme has also benefitted from the double-degree cooperation with Esslingen UAS in Germany and the Erasmus+ Global activities when gaining the information for the enhancement of the degree programme aims. As the self-evaluation report states, the double degree cooperation has given JAMK and the degree programme feedback on their education by comparing two mechanical engineering degree programmes and by collecting feedback from German and Finnish students and academic staff.

The degree programme aims are consistent with the stated mission of JAMK *To create competence* within the following features:

- *by providing higher education based on the requirements of working life*
- *by carrying out applied research, development and innovation activities (RDI) that serve UAS education and which support the world of work and regional development and*
- *by organising continuing education to sustain and promote lifelong learning in working life.*

Beyond the aims students will gain:

- *extensive practical basic knowledge and skills and their theoretical foundations for working in a specialist position in the field and*
- *the ability to follow developments in the field*

The degree programme also aims for the students to gain:

- *skills for self-improvement and continuous training*
- *sufficient communication and language skills and*
- *skills required for international activities in the field.*

Overall, the degree programme aims are clearly identified and the planning is convincingly taking into account the needs of major regional companies. It could be beneficial to also include representatives from some smaller companies in the Advisory Board, e.g. such as active in the B2B sector in mechanical engineering, in particular for the Production Technologies specialisation. In addition, the emphasis on entrepreneurship could be enhanced in direct relation with the Product Development specialisation, e.g. through participation of representatives from small companies from the field in the Advisory Board.

Based on the team's assessment, the degree programme meets Standard 1 fully.

Standard 2: The programme learning outcomes, which describe the knowledge, understanding, skills and abilities that the programme enables graduates to demonstrate, are consistent with the programme aims, with relevant national qualifications frameworks (if applicable) and with the FINEEC reference programme learning outcomes.

The learning outcomes of the Degree Programme in Mechanical Engineering are described in general terms in the Study Guide and in the Principles of the curricula, including learning outcomes for each course. The degree programme's prerequisites, study goals, and structure are also described there.

The programme learning outcomes are divided into two categories: common learning outcomes and professional learning outcomes. The common learning outcomes are the same for all the bachelor's degree programmes at JAMK as follows:

- *Learning and information management competence*
- *Entrepreneurship, innovation and working community competence*
- *Internationalisation and communications competence and*
- *Ethical competence.*

The professional learning outcomes of the degree programme follow the EUR-ACE criteria.

The programme learning outcomes have been defined by expert teams at the Industrial Engineering Department and are monitored by the Head of Department together with the Head of Programme. Common learning outcomes have been defined at JAMK-level using the European and National Qualification Framework (EQF/NQF). The EUR-ACE criteria are directly linked to the learning outcomes for each course, as professional learning outcomes are defined and described directly based on EUR-ACE criteria. Linking is made public on the JAMK web site, thus it is as transparent as possible. The alignments are consistent and allow to work as an engineer in industry with specialisation in Product Development or in Production technologies directly after the degree programme studies. In summary, the defined programme learning outcomes of the degree programme along with its course learning outcomes entirely fulfil the FINEEC reference programme learning outcomes.

Based on the team's assessment, the degree programme meets Standard 2 fully.

Standard 3: The course level learning outcomes, including thesis work and possible practical training, aggregate to the programme's learning outcomes.

The general syllabus for the degree programme covers all the areas outlined in the FINEEC reference programme learning outcomes. The structure of the curriculum is constructed to support the programme's aims and learning outcomes. The mechanical engineering

studies same for all the study tracks include 15–21 ECTS of basic mathematics and physics, 11 ECTS of English, Swedish and communication, 5–45 ECTS of student well-being studies (including e.g study techniques and various forms of tutoring), 18 ECTS of mathematics and physics in mechanical engineering, 40 ECTS of basic mechanical engineering studies, 18 ECTS of machine automation, 10–15 ECTS of supplementary professional studies, 20 ECTS of studies focusing on research and innovation in practise (incl. thesis phase) as well as 30 ECTS of practical training. In addition, based on the chosen study track the studies may include 15–63 ECTS of Future Factory studies, 0–25 ECTS of maintenance, 0–25 ECTS of operations management, 0–25 ECTS of production engineering, 0–40 ECTS of applied production technology, 0–15 ECTS of basics production technology, 0–15 ECTS of user centered product development, 0–26 ECTS of product development, 0–15 ECTS of applied product development and 10–15 ECTS of elective studies.

Knowledge and understanding are addressed in 32 of the offered courses. Nine courses are related to natural sciences. Natural science skills are gained during the first to third study year e.g. in the Math3, Phys1 and Applied Mathematics and Physics courses.

Basic engineering skills are also mostly studied during the first and second year. The engineering basics are gained in courses such as the Material Technology, Manufacturing Technology and Technical Drawing and CAD courses.

In courses such as the Measuring and Quality Technique, Basics of Production Technology and Machine Components courses the students gain basic knowledge of mechanical engineering. After these studies, students will be able to explain production and measurement methods, materials, components, and tools used in mechanical engineering.

Engineering Practice is addressed in 55 of the offered courses. The ability to analyse complex engineering products, processes or systems are gained through courses such as the Product Development course, where the students learn not only to analyse but also to use appropriate methods in a product development process and develop complicated products, processes, and systems. In courses such as the Basics of Production Technology course, the students gain the ability to identify and solve production problems by choosing appropriate, well-established, analytical, and computational methods. They also learn, develop and design production processes and systems, which may include technical and economical constraints. The Production Systems 1 course is a typical course where students can learn to develop complex production systems to meet economic and technical requirements. Practical skills for realising complex engineering designs can be gained in a course such as the Machine Design Project course. In courses such as the Product Development Project course, students gain the ability to use the awareness of the forefront of their engineering specialisation in design and development. The ability to apply norms of engineering practice in their engineering specialisation can be learned in courses such as the Mechanical Engineering Design course. In the Safety Engineering course, students learn the ability to consult and apply codes of practice and safety regulations in their engineering specialisation.

Investigations and information retrieval learning outcomes are addressed in 26 of the offered courses. The research can comprise literature searches and interpretation of information as well as measurements in laboratory settings. A major part of the degree programme in which investigations and information retrieval play a major role is the Bachelor's Thesis.

The Bachelor's Thesis phase is divided into four parts in the curriculum:

1. *Thesis planning: 3 ECTS including information seeking workshops, systematic searches for information and familiarisation with source material independently. Writing and presenting a thesis plan and participating in small group and individual meetings. Management of agreements and necessary research permit issues.*
2. *Thesis writing: 2 ECTS.*
3. *Implementation: 6 ECTS including the empirical and functional phase, data collection and analysis. Participation in small group and individual meetings.*
4. *Thesis reporting and evaluation: 4 ECTS including thesis writing*

Multidisciplinary competences learning outcomes are addressed in 29 of the offered courses. During the first year, students participate the JAMK InnoFlash course. This course is a good example, in which students are trained to work in a multidisciplinary group. They learn to gather and interpret relevant data and present their findings to the client. In the English for Working Life and Swedish for Working Life language courses, the aim is for the students to find motivating ways to strengthen their language skills and develop ways of learning based on the principles of life-long learning in language studies.

Communication and team-working learning outcomes are addressed in 27 of the offered courses. The Structural Analysis Project course in which usually exchange students also take part, is an example of team working and communications. Another example is the Practical Training phase, where the student gets practical experience as a member of a working environment. Overall, in all projects, students develop the ability to communicate and work as a team member in communities of students and companies.

According to the self-evaluation report, along with its annexes, there is a good match between the FINEEC reference programme's learning outcomes and the degree programme curriculum. Based on the self-evaluation report on the course descriptions and on evidence presented during the online visit, it can be concluded that the programme provides students with the necessary knowledge and understanding for successful studies in product development and production technology in mechanical engineering. The degree programme clearly supports successful entrance into the labour market in the field of mechanical engineering for the region of Central Finland.

Based on the team's assessment, the degree programme meets Standard 3 fully.

Standard 4: The curriculum gives comprehensive information on all the individual courses of the programme, including thesis work and possible practical training, and is accessible to students.

The degree programme curriculum is publicly available on the JAMK website for the applicants, the students, and the wider audience. In addition, it is available on the JAMK intranet for the degree programme students.

The curriculum provides detailed course descriptions together with EUR-ACE learning outcomes. The information is accessible to students. Relevant data, such as ECTS credits, learning outcomes, course content, methods of teaching and learning, assessment methods, pre-requisites and study materials are defined. In addition, the suggested order of the courses in semesters is presented in a clear way. The thesis-related instructions are defined in the Study Guide, along with the more detailed guidelines in the student intranet Elmo. Information on the thesis process covers the following areas: an approved thesis proposal, a partnership agreement with the assignor, an approved thesis plan and theoretical framework, a report of the information sources used appended to the thesis plan as well as he following of thesis seminars and presentations of completed thesis projects.

However, especially new students may not understand the course descriptions in a deep sense and cannot easily choose courses on their own, thus the Head of Programme and tutors are available to guide students when selecting optional courses. The degree programme is recommended to continue its efforts in guiding students when selecting courses for the studies. For example, to provide some examples on the possible course selection to be able to participate in different working careers in industry.

Based on the team's assessment, the degree programme meets Standard 4 fully.

Standard 5: The curriculum and the course timetable enable students to graduate in the expected time.

The Head of Programme drafts the delivery of the degree programme for the next academic year every spring. The specific resource plan for each semester is prepared during the previous semester in cooperation with team leaders. The schedule for the students is made by the Study Coordinator at JAMK. Students and alumni, based on their experiences, expressed the opinion that the timetable enabled them to graduate in the expected time.

The interviewed students felt that the workload was balanced throughout the academic semesters in general. In addition, it was pointed out by the students that sometimes there are workload peaks, when several exams or submissions of a project report take place on the same date and/or very close to each other. Some of the students also highlighted their personal learning process concerning study skills and making their own schedules to support the workload balance (e.g. that they had to learn to start early to work for the projects and

not just closely before the deadline). It is recommended to guide students in organising their workload through the studies continuously and to achieve good self-management skills in order to avoid unnecessary stress and extreme work peaks. In addition, it is recommended to further develop joint calendar planning among the teaching staff, to avoid the major exams or other forms of student assessment taking place within a short timeframe.

In summary, the timetable and curriculum of the degree programme allows students to graduate in the expected time, namely in four years, by which time they will have acquired 240 ECTS.

Based on the team's assessment, the degree programme meets Standard 5 fully.

Standard 6: The criteria and process for student admission and transfer are clearly specified and published. Students should be informed of the qualifications necessary to enter the programme.

The admissions process to universities of applied sciences in Finland is regulated and specified in detail and therefore it is standardised. In addition to this, JAMK and the degree programme provide different sources of information for interested students: the JAMK website offers documents such as the Study Guide and How to Apply as well as making the criteria for admission publicly accessible. JAMK enrolment information and explanations of the process are easily available for applicants and they provide a clear understanding of the degree programme's contents and the expectations for the applicants, including information on the entry qualifications.

Admission and transfer information are specified and openly published. The necessary comprehensive information about studying is given in the Applicant's Guidebook, Study Guide and information stored on the JAMK intranet. During the interview with the students the accreditation team could find no problems or complaints with the admission process, therefore the conversation was not focused to that issue.

Based on the team's assessment, the degree programme meets Standard 6 fully.

Standard 7: Students are informed of regulations and guidelines that concern recognition of prior learning, progress of studies and graduation.

In general, procedures for recognition of prior learning are defined at the JAMK level in the JAMK Degree Regulations and Study Guide. Information regarding the recognition process can be found on JAMK website, on the intranet and in the detailed JAMK Quality Manual. At JAMK, competence is recognised either by means of an accreditation decision or an assessment decision. Additionally, recognition of prior learning and experience also takes place

in connection with studification. Studification means a process, where working is transferred into curricular learning by combining studying and work. Processes are clearly defined for both accreditation decision and assessment decision. Studification is an alternative method of developing the competence on the module or course level. It refers to combining work or project studies, such as future factory activities, with the studies. The student must draft a studification plan and document it in the manner agreed upon with the responsible teacher.

However, students could be better informed on the possibility to have their prior studies or other learning recognised. Based on the students' interviews, there is variation among the students in their awareness concerning the recognition of prior learning. As the degree programme also educates adults within its part-time implementation, it is important to ensure that all the students can benefit from the possibility to have their prior learning recognised effectively. The degree programme is advised to develop the process of informing new students on this topic.

As the degree programme implements the double degree operations jointly with its German partner institution, the recognition of the credits earned at the partner institution is a necessary part of the degree programme operations. According to the self-evaluation report, all transcripts of records of the double degree students are separately checked so that courses are placed in the correct modules and the studies are acceptable for degree programmes in both institutions and the required competences are fulfilled.

Student admission statistics are created in conjunction with student enrolment and the statistics are available on the nationwide education administration's reporting portal Vipunen. The student's study progress and achieved learning levels are followed via the student management system by the school's quality team.

Teachers monitor the study progress of the students in their courses as well as the presence: if students are absent repeatedly, the Programme Manager will ask a tutor to personally contact the student. In this way, the students' progression is efficiently managed in time, not only as a consequence of obtained marks.

JAMK and the degree programmes have clear and established procedures for awarding the certificates to the degree programme graduates. A student who has completed a bachelor's degree will receive, on written application, a certificate in Finnish, indicating the completed degree and its scope, the degree title and the name of the degree programme, the specialisation option (if any), the core content of the studies, the title of the thesis, the language of the maturity test or other assignment demonstrating their competence in the field, a statement on the language skills required for the functioning of state officials in a bilingual office, and other facts of relevance. The Diploma Supplement is an English annex, which is automatically given with a degree certificate free of charge to all students. The Diploma Supplement contains information about JAMK, the education and study attainments (transcript of records), and their level and status in the Finnish educational system.

Based on the team's assessment, the degree programme meets Standard 7 fully.

Strengths, good practice and areas for further development regarding section 2.1: planning of the programme.

The team notes the following strengths and good practice in this section:

- The cooperation is excellent between the Advisory Board, industry stakeholders and the degree programme staff.
- The degree programme strongly involves talented teaching staff with industrial backgrounds.
- The curriculum reflects the needs of the Central Finland business and industry and curriculum is updated regularly.

The team sees the following as areas for further development in this section:

- The degree programme is recommended to continue its efforts in guiding students when selecting courses for studies. For example, to provide some examples on the possible course selections to reach different kind of working careers in the industry.
- Students could be better informed on the possibility to get their prior studies or other learning recognised.
- It is recommended to further develop joint calendar planning among the teaching staff to avoid the major exams or other forms of student assessment taking place within a short timeframe.
- To strengthen the entrepreneurial aspect in the degree programme, it is recommended to also involve some smaller companies in the Advisory Board.
- JAMK has recently published an updated version of the Quality Manual. It would be useful to further improve the internal visibility of the complete manual and the quality work on the degree programme level (possibly along with a short video about the essential needs and contents); the Head of the Degree Programme, and also the involved teachers and administration, would be efficiently supported in their management and continuous curriculum development by the broader visibility of a clearly articulated common view of quality work and processes at JAMK.

2.2 Implementation of teaching and learning

Standard 8: The teaching and learning process, including the assessment of students, enables students to demonstrate that they have achieved the intended course and programme level learning outcomes. Students have an active role in co-creating the learning process and the assessment of students reflects this approach

According to the self-evaluation report, the general principle in teaching and learning in the degree programme is student-centred learning, deriving from JAMK's Pedagogical Principles set out in 2017. JAMK aims that each student is the owner of their learning process as well as responsible for it.

The degree programme has a variety of teaching and learning methods in use: lectures (also online), exercises carried out during the lectures, laboratory work along with reporting, RDI projects carried out with industrial partners, case studies, practical training along with reporting, learning games, self-study, as well as guided preparation of the thesis. Team-work is commonly used in the studies.

The degree programme uses two alternative electronic teaching and learning platforms, namely Optima and Moodle. The aim is to move all the courses to Moodle in the near future. The accreditation team was shown demonstrations of a couple of course implementations in the course of the online visit, along with the instructions, study materials, schedules and student assignments. Based on the staff interviews, the change from Optima to Moodle could be used for developing a more visual, user-friendly, and common template to for the "interface" for courses on the Moodle system.

The degree programme makes strong efforts to provide students with the necessary mathematics background and allows students to detect any weaknesses early by using self-evaluation tests on Moodle. Students who do not pass the test after 5 trials are contacted and can get support during the first weeks of the beginning of the studies to update their competences with an optional additional course. This measure allows the efficient reduction of possible drop-outs of students who have prior difficulties in the application of basic calculus rules and in the reformulation and solving of basic equations.

Strong efforts are made to follow students' progress through tutors, who contact the students, e.g. when they are absent from courses for a longer period, which has been especially necessary during the pandemic situation. The average duration of the Mechanical Engineering studies of at JAMK lies between 4 to 6 years. This corresponds well with the other universities of applied sciences in Finland. This is due to the fact, that many of the students that have enrolled in the full-time programme but in practice study part-time and work alongside their studies.

For laboratory courses, e.g. in the Material Science course students are placed in a real-life working situation in a material test laboratory. In the electrical laboratory students work on training tasks in order to learn basic laboratory skills such as using multimeters to

measure current, voltage and resistance. Assessments of laboratory work is essentially result based. Although this approach is practically oriented, the training of result visualisation and graphical representation, result reporting, and critical quantitative analysis including error analysis and discussion of measurements or fabrication precision seems somewhat underrepresented during the studies. This may explain the heterogeneous outcomes of project and thesis report results.

For project-based courses, students are the main actors concerning their learning outcomes. Especially for international projects and for multidisciplinary projects this leads currently to heterogeneous outcomes in the depths of the results and thus in the learning outcomes. While, e.g., presentation skills are assessed individually, technical writing skills are here generally considered team-work, which does not allow the assessment of the written communication skills of individual students. The degree programme should pay more attention to training and individual assessment in technical and scientific writing/reporting, prior to the bachelor's thesis phase of the degree programme.

Many students and alumni reported that they were very positive about the experience in international and multidisciplinary projects and that they appreciate problem-solving oriented courses. They have reported that international projects also gave them insight into other working cultures. The students reported that they very much liked the own working possibilities in the Protopaja Laboratory, and that in general they appreciated the infrastructure and equipment for their studies.

Several students were rather critical about the use of some cloud-based design software with limited licenses, when they could not save data on their own laptop to use for another project or simply work off-line. Several students would prefer working with desktop-based software, which they could use at home at any time on their own computers, especially during COVID, as apparently not all students have fast Internet connections. Furthermore, many students believe that not all companies will have the most expensive software, so that they expect to learn to work with several design software programs, not necessarily only the ones used by very big companies. Overall, they were positive about the proposed CAD infrastructure available for their studies.

Some students and alumni felt not especially prepared for writing reports in a structured manner. Although they have to deliver regularly reports during their studies, they were missing some practical guidelines learning to use good words and phrasing for reports for representing the methods and results. Some students felt that they had not trained well enough in English (speaking and listening) during their studies.

Students having participated in the double-degree programme were very positive about this experience.

For basic courses, the students' work and skills assessment is convincingly performed by a mixture of continuous individual exercises and reports, as well as by exams. Some teachers use detailed assessment tables in order to assess individual and group work activities in a balanced

way, especially for project work. In general students reported that they had received clear assessments on their reports and project work and that teachers gave them clear explanations and feedback and were very responsive to questions of students.

Knowledge and understanding

- knowledge and understanding of mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme learning outcomes;
- knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme learning outcomes, including some awareness at the forefront;
- knowledge and understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations, in their specialisation
- knowledge and understanding of applicable techniques and methods of analysis, design and investigation, and of their limitations, in their specialisation;

The degree programme put strong efforts into providing basic science and mathematics courses adapted to the engineering specialisations. The degree programme adequately recognises the importance of mathematics and physics as an important basis for any engineering discipline and organises the basic courses in these disciplines in a consistent and well adapted manner for engineers of the department. Students from different specialisations and different engineering degree programmes follow these courses. Teachers are proactive and integrate meaningful application examples from different engineering fields into their lectures. Due to this, the mathematics and physics courses provide an efficient (and nowadays ever more important) basis for training engineers in interdisciplinary working competences and adopting a transdisciplinary view for problem solving and engineering of systems, products, and the necessary fundamental understanding of production techniques, physical operation principles (e.g. of motors, sensors and measurement techniques) that are all highly relevant in industrial production and product development, as well as for other engineering fields in a very similar manner. The department and degree programmes are thus very well strengthened by this practice, and the common organisation of mathematics and physics courses. The possibility of future changes to the study field are also smoothly guaranteed for the students as the basic mathematics and physics courses are organised in common for all engineering study fields of the department.

Teachers from mathematics have furthermore developed an online self-assessment tests that students perform at the beginning of their studies. The test can be repeated 5 times by all students. The results are monitored on Moodle and students who do not pass the online self-evaluation are contacted by a tutor, who analyses and supports the student with adapted

study material so that the student can learn and attempt the self-assessment test again. During approximately the first half of the semester, the degree programme encourages students with difficulties in basic mathematics to follow an additional dedicated course where they can practice basic topics such as mathematical equations, in parallel with their studies in the first year. In this way, the entrance level in mathematics can efficiently be balanced during the first two months of studies.

The relevance of the trained competences in mathematics and physic is well understood by the degree programme. The basic courses also train practical skills such as using excel for data analysis, linear regressions and graphic representations, or statistical data analysis at an early stage of the studies.

Given the observed heterogeneity of in-depth analysis or quantified parts in the consulted examples of student project reports and theses, the degree programme could envisage reinforcing mathematics and physics skills again at a later stage of the studies with dedicated courses again given by mathematic and physic teachers with further physical principles and mathematical background studies also including more advanced examples that are specific to the study fields. This could help the students to still better develop their analytical skills for their understanding and development in product engineering and production techniques, including product design, performing rapid testing and quantitative analysis, and for the validation of results. Teachers of mathematics and physics would thus also naturally be involved and interact with the RDI activities in the different study fields and could efficiently contribute to facilitating and strengthening the interdisciplinary approach of the degree programme of mechanical engineering at JAMK.

Engineering practice: analysis, problem-solving, design, practice

Analysis

- ability to analyse complex engineering products, processes and systems, and to correctly interpret the outcomes of such analyses, by being able to select and having the practical skills to apply relevant established analytical, computational and experimental techniques and methods

The curriculum is divided into three study tracks: Product Development, Production and Combined Product Development and Production. The ability to analyse complex engineering products, processes, and systems as well as to correctly interpret the outcomes of such analyses, is taught throughout the degree programme. Students are trained and coached while being able to select and to accumulate the necessary practical skills. The courses available to achieve the learning outcomes vary between the study tracks; the courses are organised to provide the best available programme and outcomes in the Product Development and Production field.

Students are able to select relevant established analytical, computational, and experimental techniques and methods to study. The students need to choose their study track after the first year, but it is still easy for them to change during the second year, if needed.

Problem-solving

- ability to identify, formulate and solve complex engineering problems, by being able to select and having the practical skills to apply relevant established analytical, computational and experimental techniques and methods

Overall, problem solving is convincingly covered by the degree programme, this applies in particular to practical problem solving. CAD tools such as SolidWorks including structure simulation tools are used and training is provided on them during the degree programme, as well as e.g. through a course on finite element analysis.

Project work in the Protopaja Laboratory trains practical problem solving in a convincing manner.

Students learn to choose materials and to dimension systems according to needs.

Experimental techniques and methods could be strengthened further by more advanced and more intense laboratory training, especially in production processes and on quantifiable measurement methods which can characterise the properties of products and also should be taught to analyse the results of production processes, e.g. by measuring surface roughness, and surface profiles, colour inspection, microscopy analysis, camera inspection (2D and 3D) and/or sensor inspection for the measurement of dimensions, etc. This would also support the analytical skills for quality control of products and production processes and teach the importance of tolerances, including relevant knowledge on statistical analysis. The equipment available for the degree programme students is excellent and the teachers and other staff members around it are very motivated and competent.

Design

- ability to develop and design complex products (devices, artefacts, etc.), processes and systems to meet established requirements that can include societal, health and safety, environmental, economic and industrial constraints, by being able to select and having the practical skills to apply relevant design methodologies
- practical skills for realising complex engineering designs
- ability to use the awareness of the forefront of their engineering specialisation in design and development

The ability to design and analyse complex engineering products, processes or systems are the topics in courses such as the Product Development course, where the students learn not only to analyse but also to utilise appropriate methods in a product development process and to develop complex products, processes, and systems. The Production Systems 1 course leads students to learn to develop complex production systems and to meet economic and technical requirements. The practical skills for realising complex engineering designs are taught in the Machine Design Project course. In the Safety Engineering course, students learn the ability to consult and apply codes of practice and safety regulations in their engineering specialisation.

Examples from the group projects for product development show that the students are trained in awareness of the relevance of the end-use of products. This includes courses such as the Product Development Project course, in which students gain the ability to use the awareness of the forefront of their engineering specialisation in design and development and the Mechanical Engineering Design course in which the students learn to apply norms of engineering practice in their engineering specialisation area. Students are trained to propose solutions that can improve workflows in real world applications, such as supermarket or logistics, and to generate ideas for product development using methods such as design thinking and prototyping based on the observation and testing of production or workflow processes. Students could be trained to use these approaches in more depth also for more complex processes and product development in production processes and for the design or improvement of production machines.

The 2D- and 3D-CAD facilities and the teachers' high levels of competence in this field ensure excellent possibilities for the students to achieve the state-of-art knowhow in 3D Design. The 3D-printing equipment available enhances this learning outcome.

Practice

- ability to apply norms of engineering practice in their engineering specialisation;
- ability to consult and apply codes of practice and safety regulations in their engineering specialisation

The ability to apply norms of engineering practice is included in the third and fourth year studies and in practical training. These norms are included in the chosen study track courses. The JAMK library provide guidance on finding the materials and special standards needed in the studies.

The ability to consult and apply codes of practice and safety regulations is taught and practiced in the laboratories in several courses and exercises at the workshops and in the laboratories. The machines at the laboratories seem to be adequate and investments in new technology and machines have been made. The laboratory resources could be used more if there would be time or resources to keep the laboratories open or organise the tasks on courses more effectively.

Students have the possibility to compete in their area in international competitions. This could be expanded in the future, because now it is possible only in the International Studies course programme. In those sessions also students with lower level study rates could be taken into those courses.

Investigations and information retrieval

- ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, and to carry out simulation and analysis, in order to pursue detailed investigations and research of technical issues
- ability and practical skills to design and conduct experimental investigations, interpret data and draw conclusions
- ability to work in a laboratory/workshop setting

Overall, the students are convincingly trained to search for practical solutions and to consult the literature and to perform searches on the Internet. They have access to standards and relevant databases, e.g. on materials for the design of mechanical parts. Students have support from the library to conduct literature searches. However, the consulted examples from the final thesis works did not in general present significant technical or scientific references to support the context and basis for the problems solved. Students are trained at the beginning of the bachelor's thesis to conduct searches in the literature and other sources of information. However, they could even be trained earlier for this purpose, to apply it already during the group projects included in the many phases of the studies.

Students are trained, among other laboratory courses, on physics lab courses to conduct experimental investigations. The lab courses could be completed by tasks that require designing basic experimental set-ups and to design experimental investigations in a clever way to obtain a good answer and through efficient trials.

All students acquire basic competences to work in laboratory settings (e.g. on the Materials Testing course) as well as in a workshop setting (Protopaja). While the prototyping training in workshop settings is very convincing, practical work in laboratory settings for the quantitative analysis of products and production processes could be reinforced in all years of the studies.

Multidisciplinary competences

- awareness of the wider multidisciplinary context of engineering
- awareness of societal, health and safety, environmental, economic and industrial implications of engineering practice and recognition of the constraints that they pose
- awareness of economic, organisational and managerial issues (such as project management, risk and change management) in the industrial and business context
- ability to gather and interpret relevant data and handle complexity to inform judgements that include reflection on relevant social and ethical issues;
- ability to manage complex technical or professional activities or projects, taking responsibility for decision making
- ability to recognise the need for and to engage in independent life-long learning
- ability to follow developments in science and technology

Mechanical engineering is by definition a multidisciplinary field. By analysing the curriculum and basing an assessment on the opinion of the alumni and students, it is clear that the learners are aware of the implications of engineering practice in a multidisciplinary work environment. Moreover, common courses for all JAMK students, such as the Innoflash and Entrepreneurship courses, allow the students to solve problems and make decisions as part of a multidisciplinary team.

Especially within the broad basic training, the students are learning skills for life-long learning in the engineering field. However, due to this broad approach, the students have fewer elective courses to sharpen their profile in a cross-disciplinary manner. It would be useful, to provide each student with more in-depth knowledge in one elective topic so that they are also trained to take individual responsibility, and to also become individually specialised, e.g. in modelling, mechanical design, or a production or assembly technique. This would support them in identifying and developing a personal strength or preference already before they choose a final bachelor's thesis topic. Such technically oriented strength development could be reached through individual project work and seminar presentations, possibly in direct connection with the existing advanced courses of the degree programme and possibly as a way of implementing more "inverted class" teaching also for in-depth technical aspects of mechanical engineering.

Communication and team-working

- ability to function effectively in a national and an international context;
- ability to function effectively as an individual and as a member of a team;
- ability to cooperate effectively with engineers and non-engineers.

Especially through group work, the students are regularly placed in situations which require and teach communication and team-working skills. The degree programme has about 50% students originating from vocational training and about 50% students from an upper secondary school background. Throughout the studies the courses help to make these two student populations successfully work together. Also the degree programme includes a high percentage of part-time students, part of which are actively working in related industrial sectors in the region. Furthermore, the close and continuous cooperation with industry partners provides a great number of possibilities to develop the students' communication and team-working skills. These features provide excellent team-working opportunities for the students.

Communication skills are trained and assessed in a formal manner essentially by final project presentations of project group works.

Students also efficiently learn to apply digital methods such as video recording and video-presentations of field experiments for the documentation and communication of results.

From the reviewed examples of final project presentations, the quality and level of the student's technical presentations is rather heterogeneous. Teachers could give more clear guidelines and feedback to improve presentations in particular for an audience of engineers, such that the presentation of quantitative technical and engineering aspects or technico-scientific backgrounds would be also more deeply and more homogeneously taught. Several students reported that they did not all feel at ease writing technical reports, although they have to deliver reports regularly during their studies. Guidelines or example reports and example presentations could help students, especially those from the vocational training background as they are generally less trained in writing. This would efficiently help them to develop their written and oral technico-scientific communication skills and would also contribute to improving the overall pertinence and quality of their final theses.

Based on the team's assessment, the degree programme meets Standard 8 fully.

Strengths, good practice and areas for further development regarding section 2.2: implementation of teaching and learning

The team notes the following strengths and good practices in this section:

- The studies are arranged in a flexible manner for the part-time and full-time students.
- The implementation of the curriculum is well adapted both for students with secondary school and vocational training backgrounds. Strong efforts are made to offer a degree programme that really suites both populations and fosters synergies between them throughout their studies.
- The close and continuous cooperation with the industry partners provides a great number of opportunities to develop the students' communication and team-working skills.
- The facilities and laboratory equipment convincingly support the achievement of the practical learning outcomes (in particular Protopaja).
- Teachers from the different fields communicate well together about the alignment of the courses, e.g. teachers in basic sciences integrate meaningful application examples from different engineering fields into their lectures, well supporting the achievement of the intended learning outcomes of the degree programme.
- Students as well as alumni especially appreciated the courses which approached practical problem-solving skills.

The team sees the following as areas for further development in this section:

- Analytical skills and technical writing skills could be strengthened in the curriculum: The degree programme is advised to strengthen the training of result visualisation and graphical representation, result reporting, and critical quantitative analysis including error analysis and discussion of measurement or fabrication precision. The degree programme should pay attention to training and individual assessment in technical and scientific writing/reporting, already prior to the bachelor's thesis phase. Additionally, the degree programme could envisage reinforcing applied mathematics and physics skills again at a later stage of the studies with dedicated courses given by mathematics and physics teachers, to reinforce and teach the physical principles and mathematical background, also for more advanced applications with examples specific to the mechanical engineering study fields.
- Currently the achieved learning outcomes of the international collaboration are heterogenous among the students. The degree programme should introduce more courses taught in English.
- The coordination between the teachers related to the student workload planning and timing should be enhanced.
- The change from Optima into the Moodle could be used to develop a more visual, user-friendly, common template to be used for the ”interface” of courses on Moodle.

2.3 Resources

Standard 9: The academic staff are sufficient in number and qualification to enable students to achieve the programme learning outcomes. There are arrangements in place to keep the pedagogical and professional competence of the academic staff up to date.

The full-time teaching staff of the Industrial Engineering Department consist of three principal lecturers, 23 senior lecturers and one lecturer. In addition, there is one principal researcher and several researchers.

The CVs of the staff members were examined as part of the review process. In teaching positions, JAMK follows the competence requirements defined in the UAS Act (1 129/2014) as well as the requirements in JAMK's guiding principles. Senior lecturers must have a master's degree and pedagogical qualification of 60 ECTS. A principal lecturer must have a PhD or licentiate degree and a pedagogical qualification of 60 ECTS. Both principal researchers and other researchers must have a PhD or licentiate degree.

Aside of the permanent staff, the degree programme receives visiting lecturers from abroad each semester. In addition, the degree programme also utilises visiting lecturers from industry, primarily from Finland.

Based on the information gained from the self-evaluation report, evidence room materials, as well as online interviews, the teaching staff of the degree programme consist of highly skilled professionals with backgrounds in industry in the relevant fields. The composition of the teaching staff is consistent with the degree programme and also covers relevant fields for the future. The teachers convincingly keep their competences up to date through close collaboration with industry, e.g. also through the supervision of bachelor's thesis projects in companies. Teachers of basic sciences are also proactive in the adaption of teaching methods and include examples from mechanical engineering in their courses. The teachers are currently strongly working on the improvement of their pedagogical skills for distance learning due to COVID and for using Moodle as a new platform (having used Optima before). Through the mid-term feedback collection from the students, all teachers regularly reflect on their pedagogical ways of teaching and adapt them as well as possible to the needs of the classes directly during the semester. As a good practice, mid-term feedback collection is organised by all teachers themselves, which allows the teachers to also include specific questions which they estimate to be relevant for their specific course. By doing this, the teachers receive useful course-specific feedback during the course, can discuss feedback in a timely fashion after feedback collection with their students, and possibly adapt aspects of their courses and teaching in a timely and effective manner for their students.

New teachers follow pedagogical training courses. Furthermore, all teachers can participate in some training courses if they wish, as well as participating in conferences if they present their wishes to their superiors. The teams and the staff are encouraged to strive for continuous development in their work. There is a one-week period of work reserved every year for each lecturer's self-development.

As the degree programme contributes to the service business provision of JAMK, it also provides possibilities to enhance one's skills as part of the every-day work. According to the self-evaluation, developing international skills (staff exchange, language skills, networking skills, teaching skills in multicultural groups, etc.) plays an important part in the implementation of the strategy on the department level within the mechanical engineering.

Based on the team's assessment, the degree programme meets Standard 9 fully.

Standard 10: An effective team of technical and administrative staff supports the programme. There are arrangements in place to keep the competence of the support staff up to date.

Study admissions, library services, international services and ICT services are centralised and serve the whole JAMK. The Industrial Engineering Department has its own study coordinator. Based on the online visit and other review material, the available technical ICT and library staff are adequately trained and easily available for the students, when needed.

There are nine project engineers as well as six laboratory engineers included in the staff. They guide the students in the laboratory settings. The project engineers and laboratory engineers have to have a bachelor's degree or equivalent.

According to the students, the technical laboratory staff are responsive and help them in case of problems. Some laboratories are run in groups of 3 students and some courses do currently propose less practical laboratory work than they would like to, apparently due to limited resources (and/or possibly logistics issues with the timetable) with respect to the relatively high number of students in their courses (an example of 40 students for a laboratory was given, which seemed difficult to organise or to split with the available resources and/or logistics). A deeper case-by-case analysis from the Head of the Programme about the staff needs for the different practical laboratory training could possibly help to efficiently support teachers who propose practical laboratory training in their courses and who regularly need to develop and maintain laboratory equipment, supervise students and coach and supervise laboratory engineers and support staff in an efficient way. It could e.g. be envisaged to also involve more student-assistants, e.g. students from the third and fourth year as coaches on courses and to run laboratory courses, for training subject-specific skills, or for preparing and testing new exercises and case studies, and as support for the teachers in the correction of student exercises and laboratory reports under the direct supervision of teachers. Such involvement would also help the students to become swiftly familiar with the RDI-related

activities at JAMK. The degree programme is encouraged to analyse resource allocation needs to further support the laboratory training offered to the students and in order to fully benefit from the existing laboratory equipment.

Based on the team's assessment, the degree programme meets Standard 10 fully.

Standard 11: The students are provided adequate and accessible support services to enable the achievement of the programme learning outcomes.

The development of students' well-being at JAMK is the responsibility of a multidisciplinary well-being team, which also has experts from outside JAMK as its members. There are institutional guidelines that ensure that an accessible study environment and student healthcare services are available to the students. Students' learning and well-being are supported by study counselling, career and student tutoring and mentoring, and student psychologist services. Student associations provide sports and leisure time activities for all JAMK students.

Support services that play an essential role in helping students to achieve the learning outcomes appear to be at an outstanding level, with well-planned mechanisms surrounding students and supporting their progress towards graduation. Student services help the students with enrolments, study entitlements, student financial aid, and the overall smoothness of studies, as well as matters related to graduation. The services are described on the JAMK website and intranet for all the students.

During the first days of studies, first-year students participate in an orientation week. This initiative is important for the warm welcome of the freshmen.

A career tutor, programme coordinators, and other supervisors guide each group of newly admitted students throughout their studies. The task of the tutor is to introduce the students to university studies and monitor and promote the well-being of the group and its members during the studies. The career tutors meet with the students every academic year during the studies to discuss their academic progress. If necessary, the career tutors are assisted by the Study Counsellor, the Head of Programme and/or the Head of Department. As to the progress of the thesis, this is monitored by the thesis tutors. The Head of Programme guides students with practical training-related issues.

Students reported that most of their teachers are reactive with responses when students have questions, and that during laboratory work or for project work in Protopaja, they always find staff who can help and guide them if they cannot solve their questions among themselves.

Individual, person-related, and confidential support is clearly given to the students of the degree programme, which is quite important for a familiar and friendly relationship between the students and the UAS and which clearly contributes to a good and constructive learning atmosphere.

Based on the team's assessment, the degree programme meets Standard 11 fully.

Standard 12: The classrooms, computing facilities, software, laboratories, workshops, libraries and associated equipment and services are sufficient and accessible to enable students to achieve the programme learning outcomes.

The degree programme is located at the JAMK main campus in the heart of Jyväskylä. The main campus is provided with learning and laboratory facilities that are well equipped and serve both education and RDI. There are student lounges, webinar facilities for teachers, tube rooms (for video making), a studio for virtual background video making and classrooms with modern audio-visual equipment. The helpdesk is available for both the staff and the students.

The engineering field premises include e.g. a material technology lab, 2D- and 3D-measuring equipment, and 3D-printers. The library has lots of books and electrical material available. In addition, several group workspaces for students are there. New atomic layer deposition (ALD) equipment and the Protopaja facility for projects, sheet metal operations, 3D-printing, welding, turning and milling are both located here. The Production Automation Lab and the Fatigue Testing Lab combined with computers for students all around the campus create a good learning environment. The Energy Technology Lab, Automation Lab (e.g. pneumatics, logical controls) and the Electricity Lab can be found, too. The CAE-lab with more powerful computers (28 pieces) is available for studying with more demanding CAE-software, such as CATIA, SolidWorks and ANSYS. There are numerous facilities equipped solely with monitors to which students can connect their computers so that they can work on CAE projects with an adequate screen-size and in an ergonomic workplace setting. Most of the teaching and learning facilities on the campus are for mixed use by different educational fields and all of them have augmented reality (AR) systems for distance teaching as well. All these premises were nicely presented in the campus tour video.

Students can also study independently or in groups in a range of facilities on the campus. JAMK's free Wi-Fi enables the students to utilise their own computers while using the teaching and learning software and learning platforms on the campus, of which Optima and Moodle are the most important ones.

To study production control and engineering, JAMK has software available such as SAP (for teaching ERP) and Delfoi Planner (for advanced planning and scheduling) including MES-functionalities. The FlexSim software is used for simulating the manufacturing processes. All this software is internationally well-known and used by industry worldwide. In addition, all the software required in the course of the studies is free for the students and provided by JAMK.

In the library, there are a lot of printed books, journals, theses, standards, etc. It is also possible to use a great amount of electronic resources such as electronic books, journals and standards. The library materials are continually being updated. JAMK's students and staff can also use the electronic resources outside JAMK's network. JAMK staff members and students can place an acquisition request for material which is not available in the library collection.

The study facilities were new, well-furnished for a variety of study needs and appeared to be easily accessible for students. The facilities JAMK is able to offer to the students are highly appreciated by the accreditation team. The recent investments in a wide range of 3D-printers and ALD equipment can be used both for RDI, coursework, and student projects. The variety of laboratories convincingly supports the fact that the facilities are in-line with high-level education and consistent with the degree programme focus areas. Both interviewed parties—the students and the staff—praised their facilities.

Based on the team's assessment, the degree programme meets Standard 12 fully.

Standard 13: The HEI and the programme have external partnerships that are adequate to the achievement of the programme learning outcomes.

JAMK and the degree programme has a wide range of partnership activities. Their partners include a variety of local industries, Central Finland regional co-operation, several other universities of applied sciences and vocational schools in the region, as well as a great number of international partners. The relation to the City of Jyväskylä is close and co-operation with city authorities is constant.

The RDI projects' list in the self-evaluation material with the local industry consisted of ten projects during 2015–2021. Cooperation is based on direct contacts with companies through these RDI projects and the projects represent state-of-art technologies that are also tightly connected to JAMK's degree programme's strategic targets. Local industry partners take advantage of the RDI activities provided by JAMK and its modern RDI equipment (e.g. ALD or AM technologies). The principles of the RDI activities and JAMK project instructions are described in JAMK Process Manual (TOKA).

The activities with industry partners include practical training, joint theses, development projects, study tours, visiting lectures from industry and different kinds of course-related exercises, too. The degree programme provides research, testing, and education services to support local industries. The degree programme's expertise includes fatigue testing, ALD technique, product design with high level CAE-facilities, materials testing, and production techniques. Students are involved in many projects both in groups and individually. In these projects students have good opportunities to develop their mechanical engineering skills with the companies. Both the degree programme's Advisory Board and other interviews with the stakeholders revealed that they are very satisfied with the cooperation and the quality of the graduates.

The collaboration with higher education institutions both nationally and internationally plays an important role in the degree programme. The national and international network gives the students many study and practical training exchange possibilities. It also contributes to the exchange of staff and lecturers in both ways. The number of partner universities abroad includes 15 universities for student exchange, 8 universities for visiting lecturers and student exchanges, and 7 universities for other cooperation and student exchange.

Collaboration with partner universities enriches the teaching. International lecturers bring added value to the teaching when the visiting lecturers' contribution is carefully and systematically integrated into the courses. Student, staff, and lecturer exchanges are based on annual objectives, which are defined on the basis of the JAMK strategy. The Management Team of the School of Technology have agreed on the criteria for the university partners and these university partners are classified according to the depth of cooperation and common objectives.

The Mechanical Engineering double degree programme with Esslingen University of Applied Sciences started in 2012. Since then 11 Mechanical Engineering double degree students have graduated from JAMK. Currently 4 Mechanical Engineering students from JAMK and 2 Mechanical Engineering students from Esslingen University of Applied Sciences are studying their double degree studies.

JAMK has cooperation with LUT (Lappeenranta University of Technology) involving sheet metal fatigue testing and 3D-printing. Cooperation is also ongoing with the University of Jyväskylä and Savonia UAS.

Yearly JAMK provides a series of publications and participates in the dissemination of information and know-how. JAMK's publications are mainly created in connection with the development of teaching, research projects, RDI projects, and theses. According to the self-evaluation report, during the 2019–2020 period the mechanical engineering staff has published 14 books or articles and 14 blogs. The number of different publications is at an adequate level.

The degree programme is advised to strengthen practices that will increase the number of students taking part in exchange programmes (e.g. the double degree with Esslingen UAS), as international working skills are essential for any higher education graduate in the current global industry and business.

Based on the team's assessment, the degree programme meets Standard 13 fully.

Standard 14: The financial resources are sufficient to implement the learning process as planned and to further develop it.

JAMK's key operations are financed 76% by the Ministry of Education and Culture, 19% by the research and development activities and 5% by other sources. This new financing model for universities of applied sciences (UAS) was taken into use in 2014 and was renewed for the first time in 2017 and for the second time in 2021. Now the financing of the UAS sector is based solely on the results achieved.

JAMK's turnover and other business profits totalled 60 M€ in 2019, out of which 44 M€ came from funding from the Ministry of Education and Culture. The rest of the turnover comprised sales income from further education and service operations, income gained

by leasing facilities, as well as income from teaching services. The expenses in 2019 were: personnel 42 M€, services 8.7 M€, material and supplies 0.8 M€, allowances and benefits 1.2 M€, rents 6.8 M€, other expenses 0.4 M€ and depreciation 1.0 M€. JAMK has constantly been in good financial standing.

The Industrial Engineering Department's revenue budget for 2020 was 4.7 M€. This is divided into basic education 2.9 M€ (Ministry of Education) and other income 1.8 M€ (e.g., the RDI projects' financing, and service sales). Basic education funding is channelled mainly to the wages of the teaching and support staff, and rentals. In the self-evaluation report it is explained that the 2020 budget for running and upgrading facilities in the Industrial Engineering Department was included in the budget of JAMK. The budget for purchases of services is approx. 0.2 M€ and for materials (books, software, etc.) 0.1 M€. The 2020 budget for staff training is included in the purchase of services. 0.03 M€ were allocated as travelling expenses for the Industrial Engineering Department's staff.

Targets for the future are quite high and JAMK has to continuously improve its results and get funding outside the Finnish Ministry of Education and Culture. JAMK has special qualifications in testing and analysis services accredited (by Finas) measurement equipment calibration system. JAMK offers calibration services also for the local companies.

Overall, the degree programme shows efficient and responsible management of resources with adequate investments in relevant focus area and takes into account the industrial evolutions in the field of mechanical engineering. Investments in more personal student assistants for teachers could contribute to offering even more practical hands-on training and could support teachers in their continuous development of new exercises, laboratory exercises, and case studies as well as for the correction of student exercises or quiz development on Moodle. The early involvement of student assistants in RDI-related activities, as well as their assistance in laboratory teaching and exercises, would further strengthen the student's multidisciplinary and practical work competences.

Based on the team's assessment, the degree programme meets Standard 14 fully.

Strengths, good practice and areas for further development regarding section 2.3: resources

The team notes the following strengths and good practice in this section:

- The teachers and technical staff have a great commitment to the student learning experience.
- The laboratory and teaching staff have high-level technical competences and practical engineering experience.

- The active participation of many teachers in RDI is an indicator of good cooperation with industrial partners, which provides a significant contribution to the degree programme's learning outcomes.
- The classrooms and the laboratories are of high quality and well maintained resulting in excellent working environment for the students. The variety of laboratories convincingly supports the fact that the facilities are sufficient for high-level education and consistent with the degree programme focus areas.
- The equipment for creating digital teaching material (studios) is excellent.
- The roomy library with adequate space, is designed to function effectively as a creative working space for individuals, pairs, and groups. All the students have equal access to the facilities.

The team sees the following as areas for further development in this section:

- The degree programme is encouraged to analyse resource allocation needs for further supporting the laboratory training offered for the students and in order to fully benefit from the existing laboratory equipment.
- Some comments from the students were directed at the number of remote software licenses available. The number of some special software licenses might be increased.
- The degree programme is advised to strengthen practices that will increase the number of students taking part in exchange programmes.

2.4 Quality management

Standard 15: The quality management procedures of the programme are consistent with the quality policy of the higher education institution.

Quality management organisation and procedures are very well described in JAMK's Quality Manual and the TOKA Process Manual. JAMK's quality policy consists of the following principles:

- *Promoting quality at JAMK University of Applied Sciences,*
- *Improving work and results continuously and renewing our ways of operating, and*
- *Strengthening a quality culture that involves the members of the academic community and external interest groups.*

The Rector appoints JAMK's Quality Team. In schools, there are part-time quality officers, whose responsibilities are to ensure that the quality system works and is developed in the school. Their task is to develop JAMK's quality system as members of the JAMK Quality

Team and to support the heads of department and R&D managers in implementing quality management in education, RDI work, and service business. The quality officers report to the director of their school.

The Head of the Technology Department is a member of the Schools Management Team and communicates the quality-related matters between management and The Industrial Engineering department.

JAMK's Quality Manager is responsible for the functioning of JAMK's quality system and the continuous development of the system. The Quality Manager's tasks include anticipating national and international trends in quality management and planning, coordination, follow-up, and development related to quality management. The Quality Manager presents issues in the JAMK Quality Team and reports to the Vice Rector.

JAMK has recently published an updated version of the detailed Quality Manual. The training and communication on the updated version of the Quality Manual was ongoing at the time of the online visit. It is to be launched to the whole organisation. The updated Quality Manual was not available for the whole organisation at the time of the online visit, but the old version of the manual had been available. It should be ensured that all JAMK's staff and students have access into the new Quality Manual and are informed of the changes in the handbook. It would be useful to further improve the internal visibility of the complete handbook and the quality work on the degree programme level (possibly along with a short video about the essential needs and contents); the Head of the degree programme, and also the involved teachers and administration, would be efficiently supported in their management and continuous curriculum development by a broader visibility of the clearly articulated common view of quality work and processes at JAMK. The TOKA manual is for internal usage and is accessible with limited user rights for JAMK's staff members.

The Quality Team in the Technology Department meets monthly and uses MS Teams as tool for documenting their meetings, decisions, findings, and other common materials.

The personnel of the schools are organised into expert teams. They are fully responsible for the planning of their area of responsibility, supported by the Team Leader and the Head of Department. The Team Leader is a supervisor who is responsible for setting up the teams targets in line with the targets of the school and department. The Team Leader conducts discussions with team staff members, and they are responsible for allocating resources to the team's work. The Team Leaders work under the authority of the Head of Department.

In the School of Technology, there is the School Quality Team, which assists the School Management Team in quality matters. The School Quality Team submits proposals to the School Management Team. The team is appointed by the School Director. The School Quality Team comprises the quality officer of the School of Technology, the department quality coordinators, and a student representative. The Student Representative is appointed by the Student Union.

The quality management procedures of the degree programme are consistent with the quality policy.

Based on the team's assessment, the degree programme meets Standard 15 fully.

Standard 16: The organisation and decision-making processes of the programme are fit for effective management.

The Management Team of the School of Technology comprises the School Director, department/institute heads, an administrative planner and a personnel representative. The Management Team convenes monthly. The Management Team's memorandums are available for review in the document management system. In the School of Technology, there is the School Quality Team, which assists the School Management Team on quality matters.

Each degree programme has a Head of Programme who is responsible for the structure and coordination of the realisation of the degree programme. In addition, the Product Development, Applied Research and Business Laboratories each have their own team. The personnel of the schools are organised into expert teams. Each team has a Team Leader who is responsible for developing the team and its resource planning. Teams are fully responsible for the planning of their area of responsibility, supported by the Team Leader and the head of department. The Team Leader is a supervisor who is responsible for setting up the teams targets in line with the targets of the school and department. The Team Leader conducts discussions with the team personnel, and they are responsible for allocating resources to the team's work. The team leaders work under the authority of the Head of Department.

Expert team in the Industrial Engineering Department works monthly and uses MS Teams as a tool to document their meetings, decisions, findings, and other common materials. The decision-making process is effective at the degree programme level.

According to the self-evaluation report, the JAMK quality system recognises two major ways of utilising the information produced by the quality system: daily improvement and making use of follow-up and evaluation information. Daily improvement means that all the staff and students continuously strive to make daily improvements in their own work and study. Making use of follow-up and evaluation information means that JAMK has joint procedures for processing indicators, feedback information and evaluations. All persons working at JAMK continuously develop their own work and competence to improve the quality of education, RDI activities, and services. Immediate corrective actions are carried out using various operating methods depending on the matter as follows:

- A teacher or an expert takes corrective measures related to direct feedback. Measures to be taken due to compliant-type feedback are agreed upon with a teacher's/expert's immediate superior.

- Teachers collect mid-course feedback in free form to gain insight into the students' experiences of the course. A teacher changes the course implementation based on course feedback based on their own discretion. Teachers will discuss the feedback with the Head of Department, when necessary.

Based on the team's assessment, the degree programme meets Standard 16 fully.

Standard 17: The programme reviews and develops the programme aims, curriculum, teaching and learning process, resources and partnerships and quality management in a systematic and regular manner, taking into account analysis of results of student admissions, students' study progress, achieved learning levels, student, graduate and employer feedback and graduate's employment data.

The degree programme reviews the programme in close collaboration with the Advisory Board on a regular basis, and every 6 years in a deeper manner, as it a common practice at JAMK.

The last profound reform was carried out in 2019–2020 when the Teacher Education Unit, Educational Development Department, Advisory Board, companies, and students took part in a review and update of the degree programme. The primary changes in the degree programme were an increase of the robotics, digitalisation, and material selection courses in the curriculum. Additionally, projects involving multidisciplinary teams on company-oriented topics were added to the degree programme.

At the course level, in particular mid-term evaluations are carried out by all teachers and help to include feedback of students directly in the teaching in a convincing manner, as the rate of answers for mid-term evaluations is reported to be between 60% and 80% and teachers can act and adapt immediately upon such direct feedback.

JAMK gathers statistics such as the proportion of employed students in relation to those who belong to the workforce (one year after graduation). The percentage compares well with the average for all universities of applied science. Most of the data was collected via the Vipunen portal and includes the years 2016–2018 on graduates' job placement and career progress and the match between employment and the education received.

Based on the team's assessment, the degree programme meets Standard 17 fully.

Standard 18: The programme provides public, up to date information about its objectives, teaching and learning process, resources, quality management procedures and results.

The degree programme provides public, up to date information about its objectives, teaching and learning processes, resources, quality management procedures, and results. Most of the material is available in Finnish and English.

JAMK's Quality system and quality objectives are described on JAMK's internet pages. A compact quality management brochure is available. JAMK's results includes material about recognition for quality, e.g. in FINEEC audits, Accreditations for the degree programmes and recognition by the European Commission.

Quality management procedures at the common JAMK level in education, RDI activities, service business, and in the management and support services are documented on the internet pages and are available for all visitors on JAMK's website. Procedures that JAMK deploys are explained in every area (Plan-Do-Check & Study-Act) including: planning, action, follow-up, evaluation, and quality improvement.

Students' rights and responsibilities are described in the JAMK Degree Programme Rules. This document is publicly provided (in Finnish).

Feedback procedures for the quality of education are a part of the JAMK website. There are publicly provided channels for the degree programme and course feedback, feedback from students, AVOP feedback, and the year after graduation—placement follow up. Graduate employment survey material until 2017 is available for all, the survey reports consolidated results including all JAMK degree programmes, while degree programme-specific results are less obvious. Overall, the feedback given on the degree programme by students and alumni is positive.

The degree programme could, e.g. together with the Advisory Board, select and make testimonials of alumni representatives available on the JAMK website in order to showcase various realistic career perspectives to new and present students, and include cases with testimonials also during studies or company visits. This could help students in a natural manner to prepare themselves early for their own career already early during studies.

Based on the team's assessment, the degree programme meets Standard 18 fully.

Strengths, good practice and areas for further development regarding section 2.4: quality management

The team notes the following strengths and good practice in this section:

- Quality management is documented well in the Quality Manual and Process Manual (TOKA).
- The small Quality Manual brochure is visual and easy to understand.
- Quality management is included strongly in daily routines.

The team sees the following as areas for further development in this section:

- Quality management could be made even more visible by providing training and communicating it to all staff members and students.

Overall evaluation of the degree programme

3

Upon reviewing the degree programme the team highlights the following **key strengths and good practice**:

- The cooperation between the Advisory Board, industry stakeholders and the degree programme staff is excellent.
- The degree programme strongly involves talented teaching staff with industrial backgrounds.
- The curriculum reflects the needs of the Central Finland business and industry and the curriculum is updated regularly.
- Studies are arranged in a flexible manner for the part-time and full-time students.
- The implementation of the curriculum is well adapted both for students with secondary school and vocational training backgrounds. Strong efforts are made to offer a degree programme that really suites both populations and fosters synergies between them throughout the studies.
- The facilities and laboratory equipment convincingly support the achievement of the practical learning outcomes (in particular the Protopaja facilities).

The team sees the following as **main areas for further development** of the degree programme:

- Analytical skills and technical writing skills could be strengthened in the curriculum: The degree programme is advised to strengthen the training of result visualisation and graphical representation, result reporting, and critical quantitative analysis including error analysis and discussion of measurement or fabrication precision. The degree programme should pay attention to training and individual assessment in technical and scientific writing/reporting, already prior to the bachelor's thesis phase. Additionally, the degree programme could envisage reinforcing applied mathematics and physics skills again at a later stage of the studies with dedicated courses, given by mathematic and physic teachers, focusing on the physical principles and mathematical background with more advanced application examples specific to the mechanical engineering study fields.

- Currently the achieved learning outcomes for the international collaboration are heterogenous among the students. The degree programme could introduce more courses taught in English.
- The coordination between the teachers related to the student workload planning and timing could be enhanced.
- The degree programme is encouraged to analyse resource allocation needs to further support the laboratory training offered for the students and in order to fully benefit from the existing laboratory equipment.
- Students could be better informed on the possibility to get their prior studies or other learning recognised.
- JAMK has recently published an updated Quality Manual. It would be useful to further improve the internal visibility of the complete manual and the quality work on the degree programme level (possibly along with a short video about the essential needs and contents); the Head of the Degree Programme, and also the involved teachers and administration, would be efficiently supported in their management and continuous curriculum development by a broader visibility of the clearly articulated common view of quality work and processes at JAMK.

The team recommends that the degree programme is *accredited without reservation*.

4

FINEEC Committee for Engineering Education's Decision

4

In its meeting on 24 May 2021, the FINEEC Committee for Engineering Education decided, based on the proposal and report of the accreditation team, that the Degree programme in Mechanical Engineering at JAMK University of Applied Sciences is accredited without reservation. The accreditation is valid until 24 May 2027.

Engineering programme accreditation is a degree programme specific evaluation that can lead to the European EUR-ACE® Label. The accreditation aims to support the enhancement of quality in engineering degree programmes and increase the international comparability and recognition of engineering degrees within Europe. The accreditation is voluntary for Finnish higher education institutions and degree programmes. This report presents the process and results of the accreditation of the Degree Programme in Mechanical Engineering at JAMK University of Applied Sciences in Finland.

The Finnish Education Evaluation Centre (FINEEC) is an independent agency responsible for the evaluation of education. It operates as a separate unit within the Finnish National Agency for Education. It implements system and thematic evaluations, learning outcome evaluations and field-specific evaluations. Moreover, FINEEC supports providers of education and training and higher education institutions in matters related to evaluation and quality assurance, as well as advances the evaluation of education.

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