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Mechanical Engineering
University of Twente

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Project code P2321

Contents

Summary

Standard 1. Intended learning outcomes

The BSc and MSc Mechanical Engineering have a well-developed mission to educate mechanical engineers with a T-shaped profile, with the BSc focusing on providing a broad foundation in the field with in-depth projects and the MSc focusing on specialization in one of seven areas of mechanical engineering. The panel recommends that the envisioned profile of the T-shaped profile be further developed, particularly with regard to its implementation in the individual curricula of the master's programme. The programme goals have been translated into ILOs for both programmes that are formulated at the academic bachelor's and master's level and are aligned with the requirements of the academic and professional field. The panel recommends that the ILOs of both programmes include explicit attention to 21st century skills and societal challenges, and suggests that the wording of the ILOs be clarified so that they can be better used in curriculum design. The panel appreciated the presentation of the Amsterdam location of the BSc and was impressed by the organization and implementation. It noted that the location has its own unique positioning in the Amsterdam region, but is clearly aligned with the Twente location in terms of profile, learning outcomes and quality assurance.

Standard 2. Teaching-learning environment

Both the BSc and MSc Mechanical Engineering have translated their ILOs into a well-designed and well-structured curriculum. The panel considers the content to be in line with international conventions for programmes in mechanical engineering. The BSc offers an integrated modular curriculum with a broad foundation in mechanical engineering, where projects and courses complement each other. The Amsterdam location of the BSc uses a curriculum based on that of the Enschede location, with adaptations in design and teaching methods to fit the VU learning environment. The panel was pleased to see that some of these adaptations work so well that they are also being considered for the Enschede location. The MSc has a flexible and open curriculum where students have the freedom to design an individual curriculum through a specialization, electives, internship and research assignment. The panel found that students are well supported by the specialization coordinators in constructing this individual curriculum. Given the many options available to students, the panel believes that continued attention to ensuring the T-shaped profile for each MSc student should remain a point of focus.

The panel appreciates the teaching methods and facilities and the attention to academic and professional skills and focus in both programmes. To further improve this in the BSc curriculum, the panel suggests the development of a professional skills learning trajectory, aimed at making visible to students how they gradually develop their skills through the different projects, and to assist teaching staff in assessing these skills. The choice of English as the language of instruction and the name of both programmes is appropriate given the international nature of the field. Both programmes provide adequate guidance and support for students, including students with functional disabilities. Staff and students form a close community in which students feel comfortable approaching staff for support. The admission requirements are clear and appropriate, and the panel was pleased to see that the BSc programme is making efforts to reduce the dropout rate with a matching process for prospective students. The curricula are feasible, and the MSc programme has taken steps to reduce the previously long duration of master's assignment trajectories. The panel emphasizes the importance of this and suggests that it should be extended with a streamlined supervision trajectory that includes intermediate steps to track progress and provide formal feedback.

Standard 3. Student assessment

The panel concludes that the programmes have sound assessment in place, including a four-eye principle in the composition of exams and assignments, and attention to the risks of free-riding and generative AI. The Examination Board fulfils its legal duties in a professional manner, with quality control on assessment being supported by checks by the Assessment Committee. Assessment methods are varied and appropriate to the course objectives. Oral exams for BSc projects are well designed, but could be made more transparent to students by formulating clear objectives and criteria and providing students with a justification for their grade based on these criteria. The assessment of bachelor and master assignments is designed to be valid and reliable, involving multiple examiners. The panel found that consistency in grading borderline cases could be improved. It recommends clearer descriptions of the minimum requirements for an acceptable report and calibration sessions among staff members.

Standard 4. Achieved learning outcomes

The level of the bachelor and master assignments, as well as the post-graduation careers of students, show that students of both programmes realize the intended learning outcomes.

Score table

The panel assesses the programmes as follows:

Bachelor's programme Mechanical Engineering	
Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

Master's programme Mechanical Engineering	
Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard
General conclusion	positive

Prof. dr. ir. Tine Baelmans, chair
Date: 22 January 2025

Peter Hildering MSc., panel secretary

Introduction

Procedure

Assessment

On 16 and 17 October 2024, the bachelor's and master's programmes Mechanical Engineering of the University of Twente were assessed by an independent peer review panel as part of the cluster assessment Mechanical Engineering. The assessment cluster consisted of 12 programmes, offered by the University of Twente, the University of Groningen, the TU Delft and the TU Eindhoven. The assessment followed the procedure and standards of the NVAO Assessment Framework for the Higher Education Accreditation System of the Netherlands (April 2024).

Quality assurance agency Academion coordinated the assessment upon request of the cluster Mechanical Engineering. Peter Hildering acted as coordinator and panel secretary. Yannick Slagter and Carlijn Braam also acted as secretaries in the cluster assessment. They have been certified and registered by the NVAO. Peter Hildering acted as panel secretary in the site visit of the University of Twente.

Preparation

Academion composed the peer review panel in cooperation with the institutions and taking into account the expertise and independence of the members as well as consistency within the cluster. On 26 June 2024, the NVAO approved the composition of the panel. The coordinator instructed the panel chair on her role in the site visit according to the Panel chair profile (NVAO 2016).

The programmes composed a site visit schedule in consultation with the coordinator (see appendix 3). The programmes selected representative partners for the various interviews. It also determined that the development dialogue would be made part of the site visit in the shape of thematic sessions. A separate development report was made based on this dialogue.

The programmes provided the coordinator with lists of graduates over the period between September 2022 and May 2024. In consultation with the coordinator, the panel chair selected 15 theses of each programme. Care was taken to select theses from both locations in the bachelor's programme: 9 from the Enschede location (UT) and 6 theses from the Amsterdam location (UT-VU). The selection for the master's programme included at least one thesis from all 7 active specializations except for SSI, which was launched recently and did not yet have any graduates. Furthermore, master's theses from 4 recently discontinued specializations were considered, namely Robotics, Design Engineering, Biomedical Engineering and Thermal and Fluid Engineering, as well as one master thesis from the dual degree with ITA in Brazil. The panel also took the diversity of final grades and examiners into account. Prior to the site visit, the programmes provided the panel with the theses and the accompanying assessment forms. They also provided the panel with the document site and additional materials (see appendix 4).

The panel members studied the information and sent their findings to the secretary. The secretary collected the panel's questions and remarks in a document and shared this with the panel members. In a preliminary meeting, the panel discussed the initial findings on the documentation and the theses, as well as the division of tasks during the site visit. The panel was also informed on the assessment framework, the working method and the planning of the site visits and reports.

Site visit

During the site visit, the panel interviewed various programme representatives (see appendix 3). The panel also offered students and staff members an opportunity for confidential discussion during a consultation hour. No consultation was requested. The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the preliminary findings.

Report

The secretary wrote a draft report based on the panel's findings and submitted it to an Academion colleague for peer assessment. Subsequently, the secretary sent the report to the panel for feedback. After processing this feedback, the secretary sent the draft report to the programmes in order to have it checked for factual irregularities. The secretary discussed the ensuing comments with the panel chair and changes were implemented accordingly. The panel then finalized the report, and the coordinator sent it to the University of Twente.

Panel

The following panel members were involved in the cluster assessment:

- Prof. dr. ir. M. (Tine) Baelmans, full professor at the Department of Mechanical Engineering of the KU Leuven (Belgium) [chair];
- Prof. dr. S. (Sören) Östlund, professor of Packaging Technology at the KTH Royal Institute of Technology (Sweden);
- Drs. J.J. (Jan) Steen, independent educational consultant;
- Prof. dr. A. (Atul) Bhaskar, professor in Applied Mechanics at the Department of Mechanical Engineering of the University of Sheffield (United Kingdom);
- Prof. dr. E. (Eilif) Pedersen, professor in Marine Technology at the Department of Marine Technology of the Norwegian University of Science and Technology (Norway);
- Prof. dr. D.J. (Daniel) Rixen, professor in Applied Mechanics at the Technische Universität München (Germany);
- Prof. dr. A.S.J. (Akke) Suiker, professor in Applied Mechanics at the Department of the Built Environment of the TU Eindhoven;
- Prof. dr. K. (Kari) Tammi D.Sc., Lic.Sc., M.Sc., professor in Design of Mechatronic Machines at Aalto University (Finland);
- T.W.C. (Thijs) Haartmans BSc., master's student Mechanical Engineering at the TU Eindhoven [student member];
- M. (Maartje) Janszen BSc., master's student Mechanical Engineering at the TU Delft [student member].

The panel assessing the bachelor's and master's programmes Mechanical Engineering at the University of Twente consisted of the following members:

- Prof. dr. ir. M. (Tine) Baelmans, full professor at the Department of Mechanical Engineering of the KU Leuven (Belgium) [chair];
- Prof. dr. S. (Sören) Östlund, professor of Packaging Technology at the KTH Royal Institute of Technology (Sweden);
- Drs. J.J. (Jan) Steen, independent educational consultant;
- M. (Maartje) Janszen BSc., master's student Mechanical Engineering at the TU Delft [student member].

All panel members, the secretary and the institution have signed a statement on impartiality and can confirm that the assessment was carried out in complete independence.

Information on the programme

Name of the institution:	University of Twente
BRIN-number:	21PH
Adress:	Postbus 217 7500 AE Enschede
Status of the institution:	Publicly funded institution
Result institutional quality assurance assessment:	Positive
Programme name:	B Mechanical Engineering
ISAT number:	50439
Level:	Bachelor
Orientation:	Academic
Number of credits:	180 EC
Locations:	Enschede, Amsterdam
Mode(s) of study:	Fulltime
Language of instruction:	English
Awarded degree:	BSc
Submission date NVAO:	1 May 2025
Programme name:	M Mechanical Engineering
ISAT number:	60439
Level:	Master
Orientation:	Academic
Number of credits:	120 EC
Specializations or tracks:	Aeronautics Design & Manufacturing Energy & Flow High-Tech Systems & Materials Maintenance Engineering & Operations Personalised Health Technology Smart & Sustainable Industry
Joint programme:	Dual degree with MSc Aeronautics at ITA (Brazil)
Educational minor:	Applicable
Location:	Enschede
Mode(s) of study:	Fulltime
Language of instruction:	English
Awarded degree:	MSc
Submission date NVAO:	1 May 2025

Description of the assessment

Recommendations previous accreditation panel

The previous accreditation panel provided several suggestions for improvement, such as making the intended learning outcomes more specific for mechanical engineering programmes, better defining the role of the internship in the master's curriculum, and putting a limit to extension of the master's thesis duration. The panel found that these advices have been considered carefully, leading to further improvement of the programme. See for further discussion the respective sections in the report on these topics.

Standard 1. Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

The bachelor's and master's programme Mechanical Engineering (ME) are organized by the Faculty of Engineering (ET) of the University of Twente (UT). The programmes aim to deliver mechanical engineers with a T-shaped profile: professionals who combine mechanical engineering knowledge and skills with the ability to solve problems both individually and in multidisciplinary, international teams. The programmes work with a small-scale approach, focusing on learning from each other and community building. By working together with each other and with staff members, students benefit from each other's expertise and a diversity of backgrounds. The bachelor's programme is organized in two locations (see below) and has a total intake of about 350 students per year: 250 in Enschede and 100 in Amsterdam. The master's programme has an intake of around 125-150 students per year.

The *bachelor's programme ME* educates students to become independent problem solvers on an academic level who are able to use a broad basis of knowledge and skills to research and design new products, processes and systems. During the programme, they obtain a broad foundation in the mechanical engineering discipline, a set of academic, professional and self-regulating skills and the ability to reflect on their work from a societal perspective. The teaching concept is integrated project education, where real-life engineering problems form the core of education. Students often work in project groups supervised by a tutor, using knowledge and skills they learn in courses to solve the problem at hand.

The *master's programme ME* offers students the possibility to develop themselves into professionals that are well-prepared for the work field and able to adapt to future developments in the field. The programme invites students to build their own profile as mechanical engineering. A wide range of specializations and electives allows students to build a unique profile that fits their interest and talents. The specializations are specialist areas that are the starting point for building the individual student profiles. Students build a profile by choosing a selection of courses offered by their specialization of choice, and complement this with electives, an internship and a thesis topic (see standard 2).

At the moment, the MSc ME offers the following specializations:

- *Aeronautics (AER)* focuses on aerodynamics and its interaction with acoustics, structures and propulsion. Students develop designs, technologies and materials related to for instance aircrafts, unmanned aerial vehicles and wind turbines.
- *Design and Manufacturing (D&M)* is aimed at the development of new methodological design and manufacturing methods, improving the design of the production process and facilities for high-tech manufacturing.
- *Energy and Flow (E&F)* encompasses all aspects of sustainable conversion, transport, storage and use of energy in various forms, focussing on contributions to a sustainable society.
- *High-Tech Systems and Materials (HTSM)* focuses on the performance of systems and materials used to develop products and production processes, and the creation of new and optimized materials, products and processes.
- *Maintenance Engineering and Operations (MEO)* is concerned with the maintenance of machinery, structures and production facilities. This covers both the analysis of failure behaviour and prevention as well as the logistics of maintenance.
- *Personalized Health Technology (PHT)* teaches students how to use mechanical engineering to solve societal problems related to human health, for instance through artificial organs and joints, exoskeletons and surgical tools.
- *Smart Sustainable Industry (SSI)* is aimed at innovative, digitally driven production systems, using technologies such as sensor systems, robotics, digital twins and AI.

The panel studied the mission and profile of both programmes and discussed this with various programme stakeholders during the site visit. It concludes that the programmes have an appropriate and well-developed mission to educate mechanical engineers with a T-shaped profile. The bachelor's programme offers a broad basis in the field, with opportunities to delve deeper into specific topics in the module projects. The master's programme offers a relevant and attractive selection of specializations, allowing students to specialize in a topic of choice. Master's students can broaden or deepen their knowledge and skills in composing their individual curriculum within their specialization. The programme has a mechanism in place to ensure the coherence of each individual study programme (see standard 2), with attention to sufficient broadness and specialization. The panel appreciates that the MSc accounts for the T-shaped profile in this way. At the same time, it considers the exact meaning of a T-shaped professional to be open to interpretation in the current set-up where the curriculum is spread out over seven different specializations. It therefore advises to further develop the envisioned profile of a MSc ME graduate, and determine what elements should be present in all individual curricula to realize this.

Intended learning outcomes

The goals of the programmes have been translated in a set of eleven intended learning outcomes (ILOs) for each programme (see appendix 1). To keep the programmes aligned with the expectations of the professional field, the programmes have an Industrial Advisory Board, consisting of members of ten local companies, chosen to be a good reflection of the field of mechanical engineering. This Board meets twice a year to discuss developments in the field and the programme.

The panel appreciated the ILOs of the programme and noted that they were formulated at an academic bachelor's and master's level respectively. It also concludes that the ILOs adhere to the requirements of the field as formulated in the domain-specific framework of reference. The professional field is strongly involved in the programme, safeguarding that the programme goals remain aligned with the demands from the professional field. The involvement includes not only the Industrial Advisory Board, but also connections established through internships and research assignments.

During the site visit, the panel spoke with management, staff and students about the attention given to 21st century skills and societal challenges in the programmes, such as issues related to sustainability, diversity and inclusion and associated skills to address these, such as cross-cultural communication, innovative and creative thinking, and social responsibility. It established that the courses and projects often tailored to societal challenges, but that there are no explicit goals and learning outcomes related to these aspects. The panel recommends formulating goals related to 21st century skills and societal relevance and include this in the ILOs of both programmes. The panel learnt that the programme management aims to update the ILOs of both programmes in the coming years, starting with those of the bachelor's programme, and considers this to be a good opportunity to include these elements.

Another element that the programmes could consider in the update of the intended learning outcomes is their usefulness in designing the curriculum. The ILOs accurately describe the main goals of the programmes in an elaborate way, yet also allow for a broad interpretation when it comes to designing the curriculum. The panel suggests that programmes might consider whether the ILOs could be more clearly articulated to provide direction for future curriculum choices. For example, the panel's recommendation above to implement the T-shaped profile in the individual MSc curricula could be grounded in the ILOs if these were to include a more specific description of what is meant by such a profile.

BSc location Amsterdam

Since 2019, the bachelor's programme is offered on two locations: Twente and Amsterdam. The Amsterdam location (referred to as BSc ME UT-VU in this report) is organized in cooperation between the Vrije Universiteit Amsterdam and the UT. It was launched as a result of the shortage of qualified engineers in the Netherlands, as well as the relatively low number of students in Amsterdam and the rest of North Holland that choose an engineering programme. The BSc ME UT-VU aims to provide these students with the opportunity to choose an engineering programme closer to home. Education is based on the same learning outcomes and educational philosophy as the Enschede programme (referred to as BSc ME UT), but organized separately. Students register either for the Enschede or the Amsterdam location and follow their education in separate cohorts. The UT-VU curriculum was designed using the UT curriculum as basis, but was adapted to fit the semester-based structure used at VU. The resulting differences in content and sequence of courses have led to two separate curricula: it is not the intention that students switch between the two locations. Both BSc ME UT and ME UT-VU students obtain the same diploma from the University of Twente upon completion of the programme. The BSc ME UT-VU is fully embedded in the quality assurance system of the UT, and falls under the responsibility of the ME Programme Committee and Examination Board of the UT.

During the site visit, the panel spoke with several representatives of the Amsterdam location, including management, staff, students and alumni. The panel was impressed by the vision and implementation of the Amsterdam location, and got the impression that the Amsterdam location is of an added value to both UT, VU and (prospective) students in the Amsterdam region. The Amsterdam and Twente locations are clearly two interpretations of the same programme, and are aligned in terms of profile, learning outcomes and quality assurance. The implementation of the Amsterdam location will be further discussed under standard 2.

Considerations

The BSc and MSc Mechanical Engineering have a well-developed mission to educate mechanical engineers with a T-shaped profile, with the BSc focusing on providing a broad foundation in the field with in-depth projects and the MSc focusing on specialization in one of seven areas of mechanical engineering. The panel recommends that the envisioned profile of the T-shaped profile be further developed, particularly regarding

its implementation in the individual curricula of the master's programme. The programme goals have been translated into ILOs for both programmes that are formulated at the academic bachelor's and master's level and are aligned with the requirements of the academic and professional field. The panel recommends that the ILOs of both programmes include explicit attention to 21st century skills and societal challenges, and suggests that the wording of the ILOs be clarified so that they can be better used in curriculum design. The panel appreciated the presentation of the Amsterdam location of the BSc and was impressed by the organization and implementation. It noted that the location has its own unique positioning in the Amsterdam region, but is clearly aligned with the Twente location in terms of profile, learning outcomes and quality assurance.

Conclusion

The panel concludes that the bachelor's and master's programmes Mechanical Engineering meet standard 1.

Standard 2. Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Curriculum: BSc ME UT

The bachelor's curriculum in Twente consists of 180 EC, divided into twelve modules of 15 EC each. The full curriculum is provided in appendix 2.

- Nine of the modules (M1- M8 and M11) are *thematic modules* that combine theoretical and practical courses around a specific theme, such as Energy and Materials, Design and Mechanics, and Fluid Mechanics & Heat Transfer. Central to each module is a project in which students integrate and apply the knowledge and skills obtained in the courses. These are typically group projects for groups varying from 2 to 12 students focusing on an authentic and complex problem. Students are required to not only come up with a solution to the problem, but also manage the group process themselves. Each group is supervised by a tutor that assists students, even though the role of the tutor decreases further in the curriculum. At the same time, the complexity of the problems increases, allowing students to develop their collaborative skills throughout the curriculum. Teaching methods in the regular courses are a mix of lectures and student-centered methods, such as interactive lectures, group assignments, tutorials and practical sessions.
- M9 and M10 form a 30 EC *minor*, which students can use to broaden their general academic competences, specialize in a subfield of mechanical engineering or following electives aimed at meeting the entry requirements for their preferred master's education. The UT has several pre-made minor programmes, including an educational minor leading to a secondary qualification ('tweedegraads bevoegdheid') as secondary school teacher in physics, mathematics or engineering. Students can also propose their a free minor to the ME Examination Board.
- The final module, M12, is dedicated to the *bachelor assignment*. This is an individual research project in which students choose a research problem offered and supervised by one of the research chairs involved in the programme. These assignments can be carried out either within one of the departments or in collaboration with a company. Students go through the entire research cycle, from defining the problem statement to presenting a scientific paper as end product of the assignment. In addition to the scientific paper, students write a reflection report to consider the societal implications of the technology they are investigating. Students complete their bachelor

assignment at a thesis conference, where all students present their papers to staff members and fellow students.

The BSc ME includes an academic skills learning line, in which students learn to conduct scientific research, including the use of literature review, formulating research questions and presenting scientific results. This learning line culminates in the bachelor's assignment. At the end of the programme, students are also guided in choosing a master's programme, and (in the case of the MSc ME) a master's specialization. In addition, regular company visits, guest lectures and extracurricular lunch lectures with companies provide a link with the professional field.

Based on the documentation and interviews during the site visit, the panel concludes that the BSc curriculum is well structured and well designed. The content is in line with the intended learning outcomes and international conventions. The courses and projects in the modules complement each other, with students using the knowledge and skills taught in the courses to carry out the project, and using the projects to process and apply the course content. Teaching methods are varied and appropriate to the learning objectives of the courses, with sufficient attention to both academic and professional skills. Students can tailor the curriculum to their own preferences in the third year by choosing a minor and bachelor assignment topic.

The panel spoke to staff and students about the progression of skills development throughout the module projects. It learned that the increasing level of skills such as group work and problem-solving skills are embedded in the design of the project and the amount of guidance students receive. As the curriculum progresses, students are increasingly expected to manage their own group process, planning and working methods. The panel is positive about this structure and believes that it allows students to reach increasingly higher levels of professional skills. At the same time, students are not fully aware of this structure. This was most evident in a discussion about the assessment of each group project. To address this, the panel recommends making the professional skills learning trajectory more insightful to students. The programme could for instance describe for students which skills are important in which projects and how the expected level builds across the different projects in the curriculum. According to the panel, this could make visible to students how they gradually develop their skills and to help both staff and students make the assessment of these skills more transparent (see also Standard 3).

Curriculum: BSc ME UT-VU

The bachelor 's curriculum at the VU Amsterdam location (see appendix 2) is based on the same educational philosophy of integrated project education as the Twente location, but has a semester structure in accordance with the educational schedule of the VU. The courses are organized in 30 EC semesters, with a larger number of courses and a larger project in each semester as compared to the 15 EC modules. The minor and graduation projects are organized in the same way as the Twente location, with the graduation project scheduled in the second part of the last semester. Lectures are organized on the VU campus, although students travel to Enschede several times per year for practical work that requires the use of workshops and instrumentation. The programme aims to cluster several activities in Enschede on consecutive days and offer facilities for overnight stay to students. Furthermore, Amsterdam students have the opportunity to follow minors at the UT and have a joint thesis conference with the Twente students. The BSc ME UT-VU teaching team includes both UT and VU teaching staff members, working under the responsibility of the UT location director at the VU. VU staff typically is involved in the non-engineering courses, such as mathematics and physics, academic skills and as tutors in projects, although the VU is investing in engineering staff to complement the teaching team in Amsterdam. UT and VU lecturers collaborate both online and on-site, and regularly travel between the two locations to work.

The panel studied the curriculum of the BSC ME UT-VU and spoke with representatives of the Amsterdam location. It was impressed by the design of the programme and concludes that the UT in Amsterdam has been able to implement a curriculum that is similar in educational philosophy and content to the UT curriculum. This means that the panel extends its assessment of the quality of the curriculum to the Amsterdam location. The curriculum is appropriately adapted to the learning environment of the VU. The panel learned that some elements of this curriculum work so well that the UT programme is considering adapting them as well, such as the semester-long projects and the continuous assessment in which students refresh their knowledge from previous years. The Amsterdam students are sufficiently facilitated to use the workshops and labs in Twente when necessary. The programme makes every effort to ensure that the teaching activities in Twente are concentrated on subsequent days to limit the amount of travel that the students must do. The research-teaching nexus is maintained by engineering staff from the UT teaching courses in Amsterdam and is increasingly strengthened by specific mechanical engineering staff appointed at the VU. From the interviews with programme representatives, the panel concludes that the cooperation between the universities and the staff departments works well in practice.

Curriculum: MSc ME
The master's programme Mechanical Engineering has a flexible curriculum that allows students to develop their own profile. It is structured into specialization courses (30 EC), elective courses (30 EC), an internship (15 EC) and a graduation assignment (45 EC).

- Students choose their *specialization courses* in one of the seven specializations (see standard 1). Per 2020, these are faculty-wide, cross-departmental specializations, as opposed to the department-specific specializations offered pre-2020. This revision was made to allow students to get a broader perspective on a specific topic, ranging from fundamental to applied. Each specialization is managed by a coordinator that takes care to compose a balanced and distinctive list of specialization courses. Prior to the start of the curriculum, students have a meeting with the specialization coordinator of their chosen specialization in which they discuss their goals and preferences. After this meeting, the student selects six 5 EC-specialization courses from this list, which the coordinator checks to ensure that these cover all intended learning outcomes.
- In addition, students choose 30 EC of *elective courses*, which can be additional specialization courses from their own or from another ME specialization, or from another MSc programme if these are of added value to the student.
- The main objective of the *internship* is to put acquired knowledge and skills into practice in a professional engineering environment. Students can opt for a company or research internship, in line with their envisioned future career. It is supervised by an external supervisor from the internship organization, under responsibility of the internal UT internship supervisor, who also must approve the proposal. Before the start of the internship, students decide upon personal learning goals to pursue during the internship. Reflection on these goals, together with an internship report, form the final product of the internship (see standard 3).
- The *graduation assignment* is a research project in the field of the own specialization, carried out under the responsibility of one of the ME research chairs associated with the specialization. Students are required to demonstrate a large degree of independence, and are expected to define perform, complete and reflect upon the project. The project is typically carried out in one of the faculty's research groups, although an in-company assignment that is part of a research project by that group is also an option. In that case, the student is supervised by both an internal supervisor from the programme and a daily supervisor from the company. Students complete the assignment with a research report and a presentation and defence during a public colloquium.

The courses in the MSc ME offer a wide variety of educational methods, ranging from interactive lecturers to practical sessions and project-based courses. The main focus is on student-centred educational methods, often in the form of group work in small teams and peer learning between students. Courses typically have a strong connection to research and the professional field, with frequent guest lectures by UT researchers on on-going research or by people form the professional field on authentic challenges in practice.

After reviewing the structure and content of the curriculum, the panel concludes that the MSc ME has a curriculum appropriate to the master's level of the programme. It provides ample opportunity for students to specialize in several relevant areas of mechanical engineering and to further tailor the curriculum to their own preferences and professional interests. Students are well supported in the design of their individual curricula, with specialization coordinators monitoring the coherence of the curricula and their alignment with the programme's ILOs. Students have some choice as to whether they wish to broaden or deepen their knowledge and skills in ME, allowing them to shape their own T-shaped profile. Following the discussion under Standard 1, the panel believes that this is a recurring point of attention given the openness of the curriculum, and that a clearer definition of the T-shaped professional would help to ensure that all graduates have the breadth and depth in their individual curriculum necessary to qualify as such (see standard 1).

Teaching methods in the MSc are varied. The panel noted that the specialized nature of most courses results in relatively small student groups that allow for interactive teaching and a close link to the research expertise of the teacher. In general, the curriculum pays ample attention to both the academic and professional aspects of mechanical engineering. In addition to the course content, this is most evident in the internship and research assignment. Both elements have clear goals and outcomes, with the internship aimed at working in an external environment and the research assignment aimed at carrying out the full research cycle in an academic research project. The panel considers that the balance between these two elements is well implemented. It has learned that both the internship companies and the Industry Advisory Board would prefer longer internships, but the panel understands and supports the programme's decision to keep it at 15 EC to leave sufficient room for the other curriculum content.

A special instance of MSc ME is the dual degree with the MSc Aeronautics and Mechanical Engineeringof the Instituto Tecnológico de Aeronáutica (ITA) in Brazil. In this dual degree, students combine the HTSM or Aeronautics specialization with additional courses in aerospace engineering and/or aircraft maintenance at ITA, at the expense of the internship and with a shorter graduation assignment (40 EC). After completion, they receive a degree from both programmes. Students that start this dual degree at the UT, follow 60 EC of specialization and elective courses, followed by a second year in Brazil. There they follow three courses (equivalent to 30 EC), and perform their research assignment. Students starting in Brazil follow an equivalent of 60 EC of courses in their first year, followed by a second year at the UT, where they follow 20 EC of specialization courses and perform their research assignment. In both cases, research assignments are co-supervised by an ITA and UT supervisor to safeguard that these meet the requirements of both programmes. To be admissible to this dual degree, students need demonstrable pre-knowledge in aerospace management and aircraft engineering. The UT offers a dedicated 30 EC minor that students can follow in their bachelor’s elective space to become eligible for this dual degree. The panel concludes that the dual degree is appropriately designed and is an attractive option for students who wish to further specialize in aeronautics and work in an international context. The adapted curriculum allows students to achieve the learning outcomes of the MSc ME, with the international exchange fulfilling the objectives of the dropped internship.

Language and internationalization
The language of instruction, as well as the programme name, of both programmes is English. This decision was made to prepare students for working in an international context. Mechanical engineering is an internationally oriented field, and graduates in both academia and industry can be expected to work in an international environment with colleagues and/or clients from different cultural backgrounds. By introducing students to this international context, the programmes aim to prepare students well for the professional field. As part of this, the programmes deliberately compose project groups that mix Dutch and international students to increase intercultural collaboration. To ensure that all teachers have a sufficient command of English, the programmes assess all its teaching staff members on their English language proficiency. This assessment consists of an expert from the UT's language centre listening in to a lecture and providing recommendations whether or not extra language training is required. Students with international prior education must demonstrate proof of English-language proficiency.

The panel approves of the choice of English language education for both programmes. It confirms the programmes' rationale that this corresponds to the nature of mechanical engineering as an internationally oriented field. It appreciates the deliberate attention to intercultural collaboration in both programmes, as well as the careful monitoring of English level proficiency of staff as well as students.

Learning environment
The programmes aim for a personal approach to students, where the teaching staff and programme management is visible and approachable to students. To this end, the programmes invest in community building between students as well as staff and students. Student association W.S.G. Isaac Newton plays a central role in this by offering a home base to students for socializing and information provision, as well as organizing social events in collaboration with the programme management. Next to this, the programmes use both staff and student mentors for first year BSc students. Student mentors are senior students that assist new students in finding their way in the programme, whereas staff mentors mostly focus on study progress in relation to the Binding Study Advice (BSA). Furthermore, each BSc project group has a tutor (staff member or student assistant) that does not only help students with organizing the project, but also has a signalling function for any personal issues of students. For the MSc, the teaching staff members and specialization coordinators are the main point of contact for students. For all students, a study adviser is available for counselling and study planning, as well as information provision on topics like internships, minors, rules, regulations and requirements. The study adviser can also proactively approach students when the student shows insufficient study progress. The Faculty ET offers a wide range of labs and workspaces for students to use during projects and practicals. During the bachelor's and master's assignments, students typically work with the facilities of the department that offers the assignment.

To enhance accessibility and feasibility of the learning environment for students with functional impairments, the programmes aim to approach this in terms of possibilities instead of impossibilities. Students can indicate any impairments in their intake, which the programmes aim to address with extra facilities wherever possible. Examples are providing wheel-chair accessible classrooms, noise-cancelling headsets for students with attention disorders or alternative workplace assignments for students with motoric problems. Compared to the university averages, the programmes have a relatively high number of students with dyslexia. For these students, the programme uses test facilities that includes extra exam time and larger print formats.

Over the course of the site visit, both staff and students confirmed to the panel that the programmes are successful in creating a close community between staff and students, where students feel free to approach the teaching staff and programme management for information, guidance and support. This was also felt by

the Amsterdam students, who indicated that they can easily get in touch with both VU and UT staff, both in person in the courses and by e-mail. This open-door policy is complemented with a fitting support by study advisers when students need extra help, as well as appropriate support for students with functional impairments. BSc students also appreciated the support during onboarding in the programme, where staff and student mentors help them to get started. The MSc students felt that they received fitting support from the specialization coordinators in helping them to navigate the individual curriculum. BSc graduates indicated that they often already get in contact with the specialization coordinator before the completion of their bachelor's if they aim on pursuing the MSc in Twente, so that they can already start composing their MSc curriculum. Incoming MSc students do the same, but in the first week of their studies. The panel learnt with appreciation that the programmes also help students to find a bachelor's or master's assignment, and internship. For research assignments, students can apply to projects offered by the research groups. For the internship, MSc students have the freedom to find their own position, although the programme has several options available as a safety net when students do not find a position on time. During the site visit, the panel also had the opportunity to visit the workshops used by the BSc programme and one of the labs that students use for practical sessions. The panel was impressed by these facilities. Overall, the panel is positive on the supportive learning environment, guidance and information provision of both programmes.

Admission and feasibility
The BSc ME admits students with a Natuur & Techniek profile, as well as students with other profiles with Mathematics B and Physics. Students with a *hbo-propedeuse* can be admitted, provided that they can demonstrate sufficient mathematics and physics background knowledge. MSc ME admits students with Dutch bachelor's degrees in either Mechanical Engineering or Aerospace Engineering, or their international equivalents. Students with a hbo-degree in Mechanical Engineering or an hbo or wo-degree in an adjacent subject are required to take a 15-60 EC pre-master's programme consisting of a selection of bachelor's programme courses with an emphasis on subjects that were absent or lacked depth in prior education.

The BSc ME has always had a substantive drop-out rate of around 40%, most of them in the first year. This applies both to the UT and UT-VU locations. This is not unique to the UT, but a long-standing issue related to students' misconceptions about what a Mechanical Engineering programme entails and the skills needed to succeed. Several initiatives have been taken in the past years to combat this. The most recent measure is a mandatory matching process introduced in 2022 to provide students with an accurate conception of the programme before enrolling, and to increase the chance of success. Prospective students fill in a questionnaire, participate in a half-day online or on-site matching event consisting of an information session, mini-lecture and mini-project, and in some cases have an interview with a senior student. Afterwards, they receive a recommendation whether the programme is a match with their interests and capabilities. The first results indicate that the mandatory matching has a positive effect on study performance of first year students; the programme hopes to see this reflected in the long-term drop-out rates.

The panel concludes that both programmes have appropriate admission requirements. It also supports the efforts the programme takes to reduce drop-out rates in the BSc. The programme showed during the site visit that the matching efforts seem to have an effect in the first year, although longer monitoring is needed to be sure. The panel commends the programme for taking steps to address the dropout rate, rather than accepting as an unalterable fact that a bachelor's programme in mechanical engineering often does not meet the expectations of new students.

Excluding dropouts, half of the BSc ME students typically graduate in three years and two-thirds in four years. There are no major differences between Enschede and Amsterdam. For the MSc ME, a small

percentage of 5-10% graduate nominally, while 50-60% graduate within three years. The remaining 40-50% take longer than three years to graduate. In discussing these success rates with students, the panel found that there were no inherent problems with on-time graduation in either the BSc or MSc programmes. In response to the recommendations of the previous accreditation, the programme has tightened the rules on master's assignments. The long master's assignment's duration were often the result of a culture that encouraged students to strive for better results rather than to finish on time. To counteract this, the programme management now requires students to complete their assignment within 12 months. The only possibility to extend is with the approval of the Examination Board. The panel welcomes this development and the attention to timely completion. At the same time, it cautions that 12 months should not become the new norm: a 45 EC thesis in a 10-month academic year should ideally take no more than 8 months. To further integrate this into the supervisory culture, the panel suggests streamlining the master's assignment trajectory to include a timeline for supervision that includes milestones to track progress and providing formal feedback on intermediate results.

Teaching staff
The five research departments of the Faculty ET are jointly responsible for the organization of BSc and MSc education. Each research department has a portfolio manager for education who is in close contact with the ME programme management. The BSc and MSc ME share a programme director, who is responsible for the organization and quality of the programmes. The portfolio managers hold quarterly meetings where educational matters are discussed and curriculum decisions are made. A total of 171 lecturers is currently associated with the programme, in most cases employed at the full, associate or assistant professor level. Nearly all teaching staff members are active researchers in the ET departments, and all either have obtained their University Teaching Qualification (UTQ), are in the process of obtaining this, or have an exemption based on previously obtained qualifications.

The panel is positive about the quality of the teaching staff associated with both programmes, including those at the Amsterdam location (see 'Curriculum BSc ME UT-VU'). The staff members have relevant research expertise and are therefore able to connect teaching and research. The assignment of staff to courses is well managed and sufficient attention is paid to the professionalization of teachers. In discussions with staff members, the panel learned that this includes not only the UTQ requirement for starting teachers, but also a recurring opportunity for continuous professional development through workshops and staff meetings. The panel believes that this is a good way for staff to keep up to date with the latest developments, such as online teaching and AI, and encourages the programme to ensure that all staff regularly attend such events.

Considerations
Both the BSc and MSc Mechanical Engineering have translated their ILOs into a well-designed and well-structured curriculum. The panel considers the content to be in line with international conventions for programmes in mechanical engineering. The BSc offers an integrated modular curriculum with a broad foundation in mechanical engineering, where projects and courses complement each other. The Amsterdam location of the BSc uses a curriculum based on that of the Enschede location, with adaptations in design and teaching methods to fit the VU learning environment. The panel was pleased to see that some of these adaptations work so well that they are also being considered for the Enschede location. The MSc has a flexible and open curriculum where students have the freedom to design an individual curriculum through a specialization, electives, internship and research assignment. The panel found that students are well supported by the specialization coordinators in constructing this individual curriculum. Given the many options available to students, the panel believes that continued attention to ensuring the T-shaped profile for each MSc student should remain a point of focus.

The panel appreciates the teaching methods and facilities and the attention to academic and professional skills and focus in both programmes. To further improve this in the BSc curriculum, the panel suggests the development of a professional skills learning trajectory, aimed at making visible to students how they gradually develop their skills through the different projects, and to assist teaching staff in assessing these skills. The choice of English as the language of instruction and the name of both programmes is appropriate given the international nature of the field. Both programmes provide adequate guidance and support for students, including students with functional disabilities. Staff and students form a close community in which students feel comfortable approaching staff for support. The admission requirements are clear and appropriate, and the panel was pleased to see that the BSc programme is making efforts to reduce the dropout rate with a matching process for prospective students. The curricula are feasible, and the MSc programme has taken steps to reduce the previously long duration of master's assignment trajectories. The panel emphasizes the importance of this and suggests that it should be extended with a streamlined supervision trajectory that includes intermediate steps to track progress and provide formal feedback.

Conclusion

The panel concludes that the bachelor's and master's programmes Mechanical Engineering meet standard 2.

Standard 3. Student assessment

The programme has an adequate system of student assessment in place.

Findings

System of assessment

Assessment in the BSc and MSc ME is based on the assessment policy of the Faculty ET. This policy describes the vision on assessment of the faculty, its organization and quality assurance mechanisms. The faculty aims for students to acquire, integrate, and apply knowledge and skills from different areas, with assessment often taking the form of integrative projects that appeal to the problem-solving skills of students. All courses have an assessment plan, in which the different types of assessment in relation to the course objects are detailed. Assessment quality assurance mechanisms include the use of the four-eye principle in designing tests and the use of predetermined assessment criteria. Concerning the use of generative AI by students, each course lists the extent to which AI can be used, and students are always required to explain when and how they used AI tools in their assignments.

Both programmes use a mix of individual and group assessment. In the *BSc ME*, projects are mostly assessed through a group product accompanied with oral group exams, where students are questioned on the project result by a team of staff members. Questions are specifically addressed at individual students to be able to determine the achievement of the learning goals on an individual level. Course assessment includes written exams, oral exams, assignments and presentations. In the *MSc ME*, assessment methods include written exams, writing research papers, presentations and group discussions during a mini conference. The internship in the MSc ME is assessed through an internship report and a student reflection on the personal learning goals determined before the internship. Both are assessed by the UT internship supervisor. Furthermore, the external supervisor provides the internal supervisor with feedback on the performance of the student in practice. Based on these three elements, the internal supervisor decides upon a final grade for the student.

The panel concludes that the programmes have a sound assessment system, which is well described in the assessment policy and the assessment plans. The panel commends the four-eyes principle in the design of exams and assignments, the measures taken to mitigate the risks of free-riding in the BSc projects, and the policy on the use of AI. Regarding the latter, the panel was pleased to hear that the programmes understand the need to keep a close eye on this as the possibilities are developing rapidly. Assessment methods are varied and appropriate to the course objectives. The panel appreciates that the MSc internship is partly assessed on personal development, which is in line with the aims of the internship.

During the site visit, the panel spoke with management, teaching staff, students and the Examination Board about a comment made by BSc students in the student chapter that group oral exams for projects sometimes felt subjective. Students mentioned that they often do not fully understand how the oral exam grades are substantiated. Even though there are rubrics for the oral exams, these are usually not used for providing feedback to individual students on exam performance. The BSc teaching staff explained that oral exams serve as a safeguard against freeriding on the one hand, and as an assessment of knowledge and skills of individual students on the other hand. The assessment of skills is progressive throughout the curriculum: for example, the programme expects more independence and initiative in projects of later modules. The panel concludes that the oral exams are well designed in principle, but that there is room for improvement in the transparency of assessment towards students. Following up on its recommendations regarding the skills learning trajectory in Standard 2, the panel recommends that clear objectives and criteria be formulated for each oral exam and that individual students be provided with a substantiation for their grade based on these criteria.

Assessment bachelor and master assignment
The assessment of the bachelor and master assignment are designed in a similar way. Both constitute of five elements. For the bachelor's assignment these are 1) the scientific paper, 2) the paper on the societal impact and embedding of their research topic, 3) performance of students during the thesis conference, 4) quality of the content and 5) quality of the process. For the master's assignment, the categories are 1) the quality of the research or design, 2) the report, 3) performance during the project, 4) oral presentation and 5) defence.

The weighted average of these five grades constitutes the final grade for the assignment. Grading is done by three ME staff members after the thesis defence, who jointly complete an assessment form to justify their grades. This graduation committee is chaired by a tenured staff member appointed as examiner, and usually also includes the internal UT supervisor if this is not the same person. One of the committee members must be external, so from another ET research group than the student and supervisor. If students performed the assignment outside the UT, at a company or other university, the external supervisor advises the internal supervisor, most prominently where it concerns the quality of the process. If a student fails on one of the five grades, the student fails the assignment. In the case of minor deficiencies, students are typically allowed to provide a supplement in a set time frame to remedy the shortcoming. Larger deficiencies or an unsatisfactory supplement results in students having to do a new assignment. MSc assignments performed as part of the dual degree Aeronautics with ITA are supervised and examined by at least one examiner from UT and one from ITA, safeguarding that the assignments adhere to the quality standards of both programmes.

The panel is positive about the procedures for the assessment of bachelor's and master's theses. The involvement of several examiners, one of whom is external to the research groups, promotes the validity and reliability of the assessment. The panel generally agreed with the grades assigned to the assignments it read for both programmes prior to the site visit and felt that they were usually adequately justified on the assessment forms. As discussed in Standard 4, one of the master's assignment reports did not, in the panel's

view, meet the quality standards for an MSc programme. The panel believes that this case could have been prevented by a rubric with clearer descriptions of the minimum requirements for an acceptable report, and recommends updating the rubric to implement this. This could promote consistency among individual examiners in grading borderline cases.

Examination Board

The programmes share an Examination Board, which also serves the MSc Sustainable Energy Technology (SET). The Board includes representation of ME, SET, and UT-VU, as well as an external member. . The Examination Board monitors the quality of the assessment system, and issues policies and guidelines to help teaching staff members comply with the quality standards. Next to the Examination Board, the programmes recently installed an Assessment Committee that checks recent course assessments and theses, and provides the programme management and Examination Board with recommendations on possible improvements to the assessment system and individual exams and assignments. The panel studied reports by the Examination Board and spoke with its members during the site visit. It concludes that the Board is fulfilling all its responsibilities in a professional manner and is in control of the quality of assessment in the programmes. The Assessment Committee is a good mechanism for reviewing and improving course and thesis assessment. Following its recommendation on thesis evaluation, the panel believes that this could be expanded to include calibration sessions for staff where examiners independently evaluate a recent thesis and compare and discuss the results.

Considerations

The panel concludes that the programmes have sound assessment in place, including a four-eye principle in the composition of exams and assignments, and attention to the risks of free-riding and generative AI. The Examination Board fulfils its legal duties in a professional manner, with quality control on assessment being supported by checks by the Assessment Committee. Assessment methods are varied and appropriate to the course objectives. Oral exams for BSc projects are well designed, but could be made more transparent to students by formulating clear objectives and criteria and providing students with a justification for their grade based on these criteria. The assessment of bachelor and master assignments is designed to be valid and reliable, involving multiple examiners. The panel found that consistency in grading borderline cases could be improved. It recommends clearer descriptions of the minimum requirements for an acceptable report and calibration sessions among staff members.

Conclusion

The panel concludes that the bachelor's and master's programmes Mechanical Engineering meet standard 3.

Standard 4. Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

Theses

As preparation for the site visit, the panel studied 15 bachelor assignments and 15 master assignments, spread over the various specialization options of the MSc. The panel generally found the reports to be of a high level for both programmes, convincingly showing that students realize the intended learning outcomes of the programme. The attention to the theoretical framework stood out to the panel, as well as the meticulous literature research in most reports.

One of the MSc reports did not meet the minimum requirements in the eyes of the panel as it was too unstructured and short. Based on the assessment form, which described a positive assessment of the student's performance in practice and during the defence, the panel could conclude that the student was likely to meet the required exit level of the programme. However, the report was substandard and should have been rejected in its current form. Due to the special circumstances, the panel considered this report to be an outlier that does not preclude a positive evaluation of the programme. The other 14 theses proved beyond doubt to the panel the high level of the MSc ME.

Performance of graduates
About 70% of the BSc graduates stay at the University of Twente, mostly in the MSc ME, with smaller percentages going to the MSc Sustainable Energy Technology, the MSc Robotics or another UT MSc programme. The other 30% usually pursue a master's degree elsewhere, with a very small percentage entering the labour market directly. MSc graduates end up working in a wide variety of companies as project engineers, mechanical engineers, process engineers or in other (technical) roles, often in the company where they did their internship or master's thesis. A number of students pursue a PhD in mechanical engineering.

Based on the post-graduation careers of students and the positive feedback from alumni during the site visit, the panel concludes that the performance of graduates from both programmes supports the conclusion that students in both programmes meet the ILOs: BSc graduates are admitted to relevant MSc programmes, and MSc graduates are in high demand by industry and are admitted to PhD positions.

Considerations
The level of the bachelor and master assignments, as well as the post-graduation careers of students, show that students of both programmes realize the intended learning outcomes.

Conclusion
The panel concludes that the bachelor's and master's programmes Mechanical Engineering meet standard 4.

General conclusion
The panel's assessment of the bachelor's and master's programme Mechanical Engineering is positive.

Recommendations

Both programmes

1. Include attention to 21st century skills and societal challenges in the ILOs.

2. Improve the rubrics of the bachelor and master assignments with clearer descriptions of the minimum requirements for an acceptable report, and consider the introduction of calibration sessions on thesis assessment for staff members.

BSc ME

3. Make the professional skills learning trajectory more insightful to students, showing how skills develop over the course of the projects. This should include clear description of objectives and criteria for the assessment of each project, which can be used to improve the transparency of the assessment of the associated oral exams to students.

4. Sharpen the definition and implementation of the T-shaped profile to ensure that all individual curricula have this profile.

5. Extend the master assignment supervision with a trajectory that includes intermediate steps for tracking progress and providing formal feedback.

Appendix 1. Intended learning outcomes

Bachelor's programme Mechanical Engineering

a. Comprehensive and thorough technical and scientific knowledge of the various sub-disciplines of mechanical engineering (mechanics, fluid mechanics, heat transfer, energy, systems and control, dynamic systems, design and construction) and the skills to use this knowledge effectively.
b. Thorough knowledge of methods, paradigms and tools to analyse and interpret data.
c. The ability to contribute to the solution of mechanical engineering problems using a systematic approach that includes analysis, the formulation of subproblems and the evaluation of the implementation.
d. The ability to integrate theory and practice from a range of mechanical engineering subjects.
e. The ability to use the techniques, skills and modern engineering tools, whenever relevant for mechanical engineering practice
f. The ability to design a mechanical engineering system, component or process to meet desired needs, within defined boundary conditions
g. The ability to effectively communicate with professionals about one's own work and its relevance and impact in various contexts.
h. The ability to operate as part of a (interdisciplinary and international) team, to take initiative, and to recognise and fill gaps in one's knowledge.
i. The ability and attitude to evaluate the impact of one's own work from a technological, social and ethical perspective and take professional responsibility for one's decisions.
j. The ability to continue one's education in a subsequent master's programme.
k. The attitude and ability to maintain and continuously improve one's academic and professional skills (life-long learning).

Master's programme Mechanical Engineering

a. Advanced level of knowledge within at least one sub-disciplines of Mechanical Engineering and the ability to apply this knowledge in design and research in this area.
b. The ability to design and conduct experiments, to develop models and simulations
c. The ability to identify, formulate and solve mechanical engineering problems by designing and development of innovative solutions, including evaluating the feasibility
d. The ability to integrate theory and practice from a range of mechanical engineering subjects
e. The ability to use the techniques, skills and modern engineering tools, whenever relevant for mechanical engineering practice
f. The ability to design a mechanical engineering system, component or process to meet desired needs, within defined boundary conditions
g. The ability to effectively communicate with professionals about one's own work and its relevance and impact in various contexts.
h. The ability to work independently on a design or research assignment
i. Insight into the complex working of modern industrial organisations
j. The ability to decide about the first step in their professional career
k. The attitude and ability to maintain and continuously improve one's academic and professional skills (life-long learning).

Appendix 2. Programme curriculum

Bachelor's programme Mechanical Engineering (location Enschede)

Programme Bachelor Mechanical Engineering 2023-2024

B1	**ME - 1 - Design and Manufacturing** **Wieteke de Kogel**	**202300048**	**EC**	**ME - 2 - Energy and Materials** **Ton Bor**	**202000108**	**EC**
	Calculus 1A	202300055	2.5	Calculus 1B	202001201	3.0
	TIME	202300054	1.5			
	Statics	202300049	2.0	Engineering Thermodynamics 1	202300056	3.0
	Modelling and Programming 1	202300050	1.0	Modelling and Programming 2	202300057	1.0
	Manufacturing Systems	202300052	2.5	Materials Science 1	202000110	3.0
	Technical Product Definition	202300051	1.5	Project Analysis of an Energy System & Ac. Skills 2 (≥ week 4)	202000111	4.0
	Project Design of a Mechanical Tool & Ac. Skills 1	202300053	4.0	Project Design of a Mechanical Tool & Ac. Skills 1 (week 1. 2)	202000112	1.0
B2	**ME - 5 - Dynamic Systems** **Jan de Jong**	**202000126**	**EC**	**ME - 6 - Product Design** **Jamal Seyyed Monfared Zanjani**	**202000131**	**EC**
	Vector Calculus	202001228	2.0	Processing and Properties of Polymers	202000132	3.0
	Dynamics 1	202000127	4.0	Elasticity Theory	202000133	2.0
	System Analysis	202000128	4.0	Tribology	202000134	2.0
	Project Design Principles & Ac. Skills 5	202000129	5.0	Project Product Design & Ac. Skills 6	202000135	8.0
B3	**ME - 9 - Minor**		**EC**	**ME - 10 - Minor**		**EC**
	Minor, free choice		15.0	Minor, free choice		15.0

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ME - 3 - Energy and Sustainability **Genie Stoffels**	**202000114**	**EC**	**ME - 4 - Design and Mechanics** **Justine Decrozant-Triquenaux**	**202000121**	**EC**
Calculus 2	202001218	3.0	Linear Algebra	202001210	3.0
Engineering Thermodynamics 2	202300058	1.5	Mechanics of Materials	202300060	3.0
Modelling and Programming 3	202300059	1.5	Modelling and Programming 4	202300061	1.5
Materials Science 2	202000116	2,0	Machine Elements	202300282	3.0
Introduction to LCA	202000117	2,0			
Project Design of an Energy System & Ac. Skills 3	202000119	5.0	Project Design of a Construction & Ac. Skills 4	202300283	4.5
ME - 7 - Fluid Mechanics & Heat Transfer **Rob Hagmeijer**	**202000137**	**EC**	**ME - 8 - Mechatronic Design** **Wouter Hakvoort**	**202000142**	**EC**
Fluid Mechanics 1	202000138	3.5	Dynamics 2	202000143	4.5
Heat Transfer	202000139	3.5	System and Control Engineering	202000144	4.0
Project Fluids Engineering & Ac. Skills 7	202000140	8.0	Project Mechatronics & Ac. Skills 8	202000145	6.5
ME - 11 - Production Systems Engineering **Roberto Reyes Garcia**	**202000147**	**EC**	**ME - 12 - ME Bachelor Assignment** **Adelien Heutink**	**202000153**	**EC**
Statistics	202000148	2.5	ME BSc Research Assignment	202000154	12.0
Introdution to Finite Element Method	202000149	3.5	ME BSc Societal Embedding Assignment	202000155	3.0
Academic Research & Skills	202000150	3.5			
Project Production Systems Engineering	202000151	5.5			

Bachelor's programme Mechanical Engineering (location VU)

UT-VU Curriculum BSc ME 2022-2023

YEAR	SEMESTER	THEME	8 WEEKS				8 WEEKS				4 WEEKS			
			UT code	VU code	Block 1		UT code	VU code	Block 2		UT code	VU code	Block 3	
1	SEM 1 201900008	Manufacturing	201900010	XBT_0002	Statics	4	201900011	XBT_0003	Mechanics of Materials	4	201900016	XBT_0008	Continuous Assessment 1	0,5
			201900009	XBT_0001	Mathematics: Linear Algebra	2	201900009	XBT_0001	Mathematics: Linear Algebra	1				
			201900015	XBT_0007	Project & Academic Skills 1: Manufacturing	1,5	201900015	XBT_0007	Project & Academic Skills 1: Manufacturing	3,5	201900015	XBT_0007	Project & Academic Skills 1: Manufacturing Skills	2 1,5
			201900014	XBT_0006	Intro to Mechanical Engineering	1								
			201900013	XBT_0005	Manufacturing 1	1,5	201900013	XBT_0005	Manufacturing 1	2,5	201900013	XBT_0005	Manufacturing 1	1
			201900012	XBT_0004	Materials Science: Metals and Alloys	2	201900012	XBT_0004	Materials Science: Metals and Alloys	1	201900012	XBT_0004	Materials Science: Metals and Alloys	1
			UT code	VU code	Block 4		UT code	VU code	Block 5		UT code	VU code	Block 6	
	SEM 2 201900017	Energy Transition & Sustainability	201900020	XBT_0012	Engineering Thermodynamics	5	201900020	XBT_0012	Engineering Thermodynamics	2,5	201900025	XBT_0017	Continuous Assessment 2	0,5
			201900018	XBT_0010	Mathematics: Calculus	2	201900018	XBT_0010	Mathematics: Calculus	2				
			201900019	XBT_0011	Project & Academic Skills 2: Energy Transition & Sustainability Skills	2,5 1	201900019	XBT_0011	Project & Academic Skills 2: Energy Transition & Sustainability	2	201900019	XBT_0011	Project & Academic Skills 2: Energy Transition & Sustainability Skills	3 0,5
			201900022	XBT_0014	Design Engineering	1,5	201900024	XBT_0016	Life Cycle Analysis	3	201900023	XBT_0015	Manufacturing Systems	2
							201900021	XBT_0013	Renewable Energy Technology	2,5				

YEAR	SEMESTER	THEME												
			UT code	VU code	Block 7		UT code	VU code	Block 8		UT code	VU code	Block 9	
2	SEM 3 202000006	Maintenance	202000008	XBT_0020	Dynamics	3,5	202000009	XBT_0021	Mechanical Vibrations	3,5	202000015	XBT_0027	Continuous Assessment 3	0,5
			202000007	XBT_0019	Mathematics: Differential Equations	2	202000007	XBT_0019	Mathematics: Differential Equations	2				
			202000014	XBT_0026	Project & Academic Skills 3: Maintenance Skills	2 1	202000014	XBT_0026	Project & Academic Skills 3: Maintenance Skills	2 0,5	202000014	XBT_0026	Project & Academic Skills 3: Maintenance Skills	3 0,5
			202000013	XBT_0025	Manufacturing 2	1,5	202000013	XBT_0025	Manufacturing 2	2	202000012	XBT_0024	Signal Analysis	2
			202000010	XBT_0022	Materials Science: Polymers	2	202000011	XBT_0023	Tribology	2				
			UT code	VU code	Block 10		UT code	VU code	Block 11		UT code	VU code	Block 12	
	SEM 4 202000016	Technology for Healthcare					202000021	XBT_0033	Elasticity Theory + FEM	3,5	202000025	XBT_0037	Continuous Assessment 4	0,5
			202100008	XBT_0038	Mathematics: Vector Calculus	2								
			202000024	XBT_0036	Project & Academic Skills 4: Technology for Healthcare Skills	2,5 1	202000024	XBT_0036	Project & Academic Skills 4: Technology for Healthcare Skills	2,5 1	202000024	XBT_0036	Project & Academic Skills 4: Technology for Healthcare Skills	3 0,5
			202000020	XBT_0032	Precision Engineering	2	202000019	XBT_0031	Control Engineering	4				
			202000018	XBT_0030	System Analysis	3	202000022	XBT_0034	Smart Industry	2,5	202000023	XBT_0035	Systems Engineering	2

YEAR	SEMESTER	THEME												
			UT code	VU code	Block 13		UT code	VU code	Block 14		UT code	VU code	Block 15	
3	SEM 5	Minor	Minor				Minor				Minor			
			UT code	VU code	Block 16		UT code	VU code	Block 17		UT code	VU code	Block 18	
	SEM 6 202100007	Thermal & Fluid Engineering and BSc Assignment	202100009	XBT_0039	Fluid Mechanics	3,5					202100014	XBT_0044	Continuous Assessment 5	1
			202000017	XBT_0029	Mathematics: Statistics & Probability	2	202100012	XBT_0042	BSc Assignment	8	202100012	XBT_0042	BSc Assignment	4
			202100011	XBT_0041	Project & Academic Skills 5: Thermal & Fluid Engineering Skills	2 1	202100013	XBT_0043	Research Skills	4	202100013	XBT_0043	Research Skills	1
			202100010	XBT_0040	Heat Transfer	3,5								

Master's programme Mechanical Engineering

MASTER MECHANICAL ENGINEERING ACADEMIC YEAR 2023-2024

SPECIALISATION COURSES

Aeronautics (AERO)

Core specialisation courses		EC	Quarter
201900091	Advanced Topics in Finite Element Methods	5	1B
202300225	Basics of Acoustics & Aero-acoustics	5	2B
202000244	Aircraft & Wind Turbine Aerodynamics	5	2A
191121710	Composites	5	1A+1B
191154731	Computational Fluid Dynamics	5	2B
201500235	Design for Maintenance Operations	5	2A
202000245	Experimental methods in Fluid and Thermal Engin	5	1A
201900074	Fundamentals of Numerical Methods	5	1A
202000246	Frontiers in Aeronautics	5	2B
191154340	Gasdynamics	5	2B
201400037	Linear Solid Mechanics	5	2A
201300039	Structural Health and Condition Monitoring	5	2A
Elective subjects		**EC**	**Quarter**
191121700	Composites Forming	5	2B
202200127	Computational Optimization	5	1B
201700173	Control for UAVs	5	2B
201900037	Flexible Multibody Dynamics	5	1B
201500036	Fluid Mechanics II	5	1A
201900097	Machine Learning in Engineering	5	2A
201400042	Nonlinear Solid Mechanics	5	2B
201600101	Theory of ODE	5	2A
201700024	Wind Energy	5	2B

Design & Manufacturing (DM)

Core specialisation courses		EC	Quarter
201400103	3D printing	5	1A
201200133	Biomechatronics	5	2B
191121710	Composites	5	1A+1B
191121720	Design, Production and Materials	5	1A+1B
191124720	Design of Production & Inventory Systems	5	2A
201000159	Durability of Consumer products	5	2A
202000033	Frontiers in Design and Manufacturing	5	2A
191137400	Laser Materials Processing	5	1B
201200146	Maintenance Engineering & Management	5	1A
191102041	Manufacturing Facility Design	5	1B
201600018	Modelling of Technical Design Processes	5	1A
202200100	Systems Engineering	5	1A
Elective subjects		**EC**	**Quarter**
202100228	Adhesion and Bonding Technology	5	2B
201900091	Advanced Topics in Finite Element Methods	5	1B
201800156	Biomechanics of Human Movement	5	2A
202300210	Capita Selecta Design & Manufacturing	5	Y
191121700	Composites Forming	5	2B
202200127	Computational Optimization	5	1B
201400244	Cost Management & Engineering	5	1B
202100128	Design for Additive Manufacturing	5	2A
191131360	Design Principles for Precision Mechanisms 2	5	2A
201900037	Flexible Multibody Dynamics	5	1B
192850730	Governing Product Development	5	1A
191150700	Integrative Design of Biomedical Products	5	1A
191127520	Lean Six Sigma Green Belt	5	2B
191102010	Life-Cycle Strategy	5	2B
202000035	Multiscale Functional Materials	5	2A
201900097	Machine Learning in Engineering	5	2A
201800003	Operations Research Techniques 1	5	1A&2A
202300064	Simulation	5	1A
191530681	Stochastic Models in Operations Management	5	2A
191531830	Stochastic Models in Production and Logistics	5	2B

Energy & Flow (EF)

Core specialisation courses		EC	Quarter
201500024	Advanced Thermodynamics	5	1B
191121710	Composites	5	1A+1B
191154731	Computational Fluid Dynamics	5	2B
201600019	Energy Conversion Technology	5	1A
201500136	Fluid Mechanics II	5	1A
191154720	Fluid Mechanics of Turbomachines 1	5	1B
202000036	Frontiers in Energy and Flow	5	2B
201900074	Fundamentals of Numerical Methods	5	1A
201400300	Multiphase Flows	5	2B
202000035	Multiscale Functional Materials	5	2A
201300039	Structural Health and Condition Monitoring	5	2A
191141700	Transport Phenomena	5	1A
Elective subjects		**EC**	**Quarter**
201900091	Advanced Topics in Finite Element Methods	5	1B
202300225	Basics of Acoustics & Aero-acoustics	5	2B
202000244	Aircraft & Wind Turbine Aerodynamics	5	2A
202001436	Biofluid Dynamics	5	2A
191121700	Composites Forming	5	2B
202200127	Computational Optimization	5	1B
201500235	Design for Maintenance Operations	5	2A
201700023	Energy from Biomass	5	1B
201600252	Energy Storage	5	2A
191157750	Engineering Acoustics	5	1A
202000245	Experimental methods in Fluid and Thermal Engin	5	1A
191154340	Gasdynamics	5	2B
201400194	Granular Matter	5	2A
202200266	Hydrogen Technology	5	1B
201400037	Linear Solid Mechanics	5	2A
201300155	Process Equipment Design	5	2A
191158510	Programming in Engineering	-	Y
201700218	Turbulent Combustion	5	2A
201700024	Wind Energy	5	2B

High-Tech Systems and Materials (HTSM)

Core specialisation courses		EC	Quarter
201900091	Advanced Topics in Finite Element Methods	5	1B
202200104	Control System Design for Robotics	5	1B
191131360	Design Principles for Precision Mechanisms 2	5	2A
191121720	Design, Production and Materials	5	1A+1B
201400046	Experimental Methods	5	2A+2B
201900037	Flexible Multibody Dynamics	5	1B
201500136	Fluid Mechanics II	5	1A
202000247	Frontiers in High-Tech Systems and Materials	5	Y
201400037	Linear Solid Mechanics	5	2A
201400042	Nonlinear Solid Mechanics	5	2B
201400044	Plastic & Elastomer Engineering	5	1B
191155700	Solids & Surfaces	5	1A
Elective subjects		**EC**	**Quarter**
202001392	Active Sound and Vibration Control	5	2A
202100228	Adhesion and Bonding Technology	5	2B
201500024	Advanced Thermodynamics	5	1B
191121700	Composites Forming	5	2B
191121710	Composites	5	1A+1B
202200127	Computational Optimization	5	1B
201500344	Elastomer Science & Engineering	5	2A+2B
191157750	Engineering Acoustics	5	1A
201900074	Fundamentals of Numerical Methods	5	1A
191137400	Laser Materials Processing	5	1B
202000256	Learning and Adaptive Control	5	2A
201900097	Machine Learning in Engineering	5	2A
202100319	Phase Transformations in Manufacturing	5	2B
202300266	Rheology & Processing of Thermoplastics	5	2A+2B
202100226	Reinforcement learning in Engineering	5	2B
202000037	Structural Dynamics	5	1A
201300039	Structural Health and Condition Monitoring	5	2A
191155710	Surface Technology	5	2A
202200111	System Identification and Parameter Estimation	5	2B
201600101	Theory of ODE	5	2A
191141700	Transport Phenomena	5	1A
191155730	Tribology	5	2A
201900098	Uncertainty Quantification & Model Reduction	5	2B

Maintenance Engineering & Operations (MEO)

Core specialisation courses		EC	Quarter
201800008	After-Sales Service Logistics	5	1B
201500235	Design for Maintenance Operations	5	2A
201300038	Failure Mechanisms & Life Prediction	5	1B
202000039	Frontiers in Maintenance	5	2B
201800034	Infrastructure Asset Management	5	2B
191102010	Life-Cycle Strategy	5	2B
201200146	Maintenance Engineering & Management	5	1A
191852630	Reliability Engineering and Maintenance Manager	5	2A
202000037	Structural Dynamics	5	1A
201300039	Structural Health and Condition Monitoring	5	2A
191155730	Tribology	5	2A
Elective subjects		**EC**	**Quarter**
202100228	Adhesion and Bonding Technology	5	2B
201900091	Advanced Topics in Finite Element Methods	5	1B
201200145	Capita Selecta - Maintenance Engineering & Oper	5	2B
202200104	Control System Design for Robotics	5	1B
191121720	Design, Production and Materials	5	1A+1B
201700294	Engineering Project Management	5	2B
201900037	Flexible Multibody Dynamics	5	1B
191102041	Manufacturing Facility Design	5	1B
191531830	Stochastic Models in Production and Logistics	5	2B
191155710	Surface Technology	5	2A
202200100	Systems Engineering	5	1A
191820120	Warehousing	5	2B

Personalized Health Technology (PHT)

Core specialisation courses		EC	Quarter
201800156	Biomechanics of Human Movement	5	2A
191121720	Design, Production and Materials	5	1A+1B
201900037	Flexible Multibody Dynamics	5	1B
201500136	Fluid Mechanics II	5	1A
202000034	Frontiers in Personal Health Technology	5	1B
201900074	Fundamentals of Numerical Methods	5	1A
191150480	Human Movement Control	5	2A
191150700	Integrative Design of Biomedical Products	5	1A
201400037	Linear Solid Mechanics	5	2A
191155700	Solids & Surfaces	5	1A
202200111	System Identification and Parameter Estimation a	5	2B
191141700	Transport Phenomena	5	1A
Elective subjects		**EC**	**Quarter**
201400103	3D Printing	5	1A
202100080	3D Bioprinting	5	2B
201500024	Advanced Thermodynamics	5	1B
201900091	Advanced Topics in Finite Element Methods	5	1B
191154740	Biophysical Fluid Dynamics	5	1A
201200133	Biomechatronics	5	2B
202001436	Biofluid Dynamics	5	2A
191154731	Computational Fluid Dynamics	5	2B
202200104	Control System Design for Robotics	5	1B
202300256	Development of Artificial Internal Organs	5	2A
202000040	Design of Flexible and Soft Robotic Systems	5	2B
191131360	Design Principles for Precision Mechanisms 2	5	2A
201700071	Identification of Human Physiological Systems	5	2B
202300030	Imaging Techniques	6	1A
202200070	Medical Certification & Human Factors	5	1B
202200100	Systems Engineering	5	1A
201600327	Tissue Engineering	5	2B
191155730	Tribology	5	2A

Smart and Sustainable Industry (SSI)

Core specialisation courses		EC	Quarter
201500518	Advanced 3D Modelling	5	2A
202000030	Automated Production Systems	5	1B
191124720	Design of Production & Inventory Systems	5	2A
202400347	Digital Twin for Smart Industry	5	1B
201600019	Energy Conversion Technology	5	1A
202400340	Frontiers in Smart & Sustainable Industries	5	1A
202000032	Industrial Robotic Systems	5	1A
191102010	Life-cycle Strategy	5	2B
201900097	Machine Learning in Engineering	5	2A
202000028	Smart Industry Systems	5	2B
202400342	Sustainability in Manufacturing	5	1B
202200111	System Identification with Parameter Estimation a	5	2B
Elective subjects		**EC**	**Quarter**
201400103	3D Printing	5	1A
201700365	Business Models for Sustainable Energy	5	1A
201700026	Electrical Power Engineering & System Integratio	5	1B
202400343	Energy System Integration	5	1A
201700075	Internet of Things	5	1A
191137400	Laser Materials Processing	5	1B
201200146	Maintenance Engineering & Management	5	1A
191102041	Manufacturing Facility Design	5	1B
192850750	Product Life Cycle Management	5	2A
202100226	Reinforcement learning in Engineering	5	2B
202400344	Smart and Sustainable Design and Packaging	5	2A
191531830	Stochastic Models in Production and Logistics	5	2B

General Electives

General elective subjects		EC	Quarter
191158500	Advanced Programming in Engineering	-	Y
201800102	Basics for Process Simulation	5	1A
191124310	CAD/CAM - research	5	2A
192850980	Intellectual Property in Product Development	5	2A
202300338	Introduction Humanitarian Engineering	5	2B
201600241	Multigrid/Multilevel Scientific Computing	5	2B
201700025	Solar Energy	5	2A
192850840	Sources of Innovation	5	1A
202100082	Theory of Inventive Problem Solving (TRIZ)	5	S
201000201	Virtual Reality	5	2B

Glossary

Y = all year
S = summer period
1A+1B = course will be spread over both quartiles
I = Refers to latest course information

Internship 202000250 (15 EC)
Graduation 202000249 (45 EC)

Appendix 3. Programme of the site visit

Wednesday 16 Oct

11.00 – 11.15	Arrival and welcome
11.15 – 11.45	Panel preparation
11.45 – 12.30	Interview management
12.30 – 13.15	Lunch break
13.15 – 14.00	Tour of the facilities
14.15 – 15.00	Interview bachelor students
15.15 – 16.00	Interview master students
16.00 – 16.30	Break
16.30 – 17.30	Interview teaching staff (bachelor + master)
17.30 – 18.00	Internal panel meeting

Thursday 17 Oct

08.45 – 09.00	Arrival and preparation
09.00 – 09.45	Interview Examination Board
10.15 – 12.30	Thematic sessions (both programmes)
12.30 - 13.30	Internal panel meeting (incl. lunch)
13.30 - 14.00	Final interview programme management
14.00 - 15.00	Concluding panel session
15.00 - 15.15	Oral feedback

Appendix 4. Materials

Prior to the site visit, the panel studied 15 theses of the bachelor's programme Mechanical Engineering and 15 theses of the master's programme Mechanical Engineering. Information on the theses is available from Academion upon request.

The panel also studied other materials, which included:

- Intended Learning Outcomes
- Domain specific reference framework
- Educational vision & philosophy
- Reflection accreditation 2018
- Programme description
- Curricula
- Programme Development Plans
- Quality Assurance ME
- Study Guidance
- Dual Degree ITA information
- Annual report Examination Board
- Assessment Policy
- Test Screening Committee
- Rules and Regulations Examination Board
- Student Charter BSc ME UT & UT-VU
- Student Charter University of Twente
- Bachelor Guide BSc
- Academic Skills BSc overview
- Assessment form Research Proposal and paper BSc
- Research Template ARS BSc
- Industrial Advisory Board
- Employer Survey
- Internship Assessment
- Alumni Survey
- Preliminary effects matching procedure BSc