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B Mechanical Engineering

M Mechanical Engineering

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Contents

Summary 4
Score table 7
Introduction 8
Procedure 8
Panel 9
Information on the programmes 10
Description of the assessment 11
Organization 11
Recommendations previous accreditation panel 11
Standard 1. Intended learning outcomes 11
Standard 2. Teaching-learning environment 14
Standard 3. Student assessment 26
Standard 4. Achieved learning outcomes 30
General conclusion 31
Recommendations 31
Appendix 1. Intended learning outcomes 33
Appendix 2. Programme curriculum 37
Appendix 3. Programme of the site visit 40
Appendix 4. Materials 41

Summary

Standard 1. Intended learning outcomes

Based on the reviewed documents and discussions during the site visit, the panel concludes that the *bachelor's programme Mechanical Engineering* has a clear profile, providing students with a comprehensive understanding of mechanical engineering principles, while integrating fundamental principles with contemporary fields. The panel appreciates the hands-on approach and the focus on applying theoretical knowledge to diverse real-world challenges, while stimulating critical thinking and problem-solving skills.

In addition, the panel concludes that the *master's programme Mechanical Engineering* has a clear focus, providing in-depth knowledge of mechanical engineering fundamentals, while promoting environmental responsibility and societal perspectives. The panel appreciates the multidisciplinary profile of the programme and the interaction between the various fields of expertise, as well as the different tracks. Students are prepared for diverse engineering roles in various sectors as both generalists and specialists, who are capable of integrating technical knowledge with broader contexts.

The panel is also positive about the interdisciplinary link with life sciences, electrical and chemical engineering, as well as the explicit attention for sustainability issues and social impact in both programmes. Furthermore, the programmes are very attentive to contemporary academic and societal questions, due to their strong connections with the professional and societal field. The panel considers the ILOs to be appropriate to an academic bachelor's and master's level respectively, and in alignment with expectations in the academic and professional field.

Standard 2. Teaching-learning environment

The panel considers the curriculum of both programmes to be well-structured and coherent. The *bachelor's programme Mechanical Engineering* addresses transferable skills through design projects, focusing on both individual and collaboration skills, although first-year projects tend to focus more on individual skills than team work. The panel values the emphasis on practical applications during projects, and the additional opportunities for research involvement during the Bachelor End Project (BEP). According to the panel, the *master's programme Mechanical Engineering* offers sufficient breadth in its specialization and projects, while its depth seems a distinctive advantage and unique selling point. It appreciates the inter- and multidisciplinary content of the curriculum, as well as the mandatory core per track. The panel concludes that sustainability and social impact are well integrated into the curricula, although the integration of a broader perspective and of soft skills, including attention to ethics, into the mandatory MSc ME curriculum (technical courses) could be enhanced. The curricula cover all ILOs and provide students with a comprehensive foundation in mechanical engineering.

The panel appreciates how the curricula are continuously updated in response to developments in the professional and academic fields. The panel supports the planned curriculum reform for the *bachelor's programme Mechanical Engineering*, noting its potential to enhance feasibility and relevance in response to contemporary challenges such as AI and energy transition. However, the panel advises the programme to be more transparent to students about the impending changes and to keep an eye on the flexibility offered to students. In addition, for both programmes, there is a need for improved monitoring through the PDCA (Plan-Do-Check-Act) cycle, particularly in relation to the connection with the ILOs. To facilitate this process, the panel believes that the role of programme directors could be strengthened. While it values the formal and informal evaluation of courses, the panel is of the opinion that more attention could be paid to data driven evaluation and providing feedback on students' feedback.

The panel is positive about the student-centred learning environment of both programmes, providing opportunities for the development of an academic community, and the active role of the study association. The courses offer varied teaching methods, with a focus on challenge-based learning and (multi- and interdisciplinary) project-based education, and an appropriate balance between theoretical knowledge and practical skills. According to the panel, students are well-supported throughout the programmes. In the *bachelor's programme Mechanical Engineering*, the panel particularly values the mentoring programme for first-year students and the organization of student groups in clusters, fostering a sense of community. The panel believes that group work and the associated peer learning can serve as valuable tools in promoting an on campus culture. There are, however, concerns regarding social safety among students, as more systematic measures need to be implemented. The panel urges the BSc programme to increase awareness of this issue and to take proactive measures to ensure a socially safe environment. In the *master's programme Mechanical Engineering*, track coordinators play an essential role in advising students on their Individual Study Programme (ISP). Further support is provided to first-year students through daily supervisors and a mentorship programme, as well as by project supervisors during their final year. The panel describes the dedicated student mentors in some tracks as a good practice. The panel concludes that all students receive adequate guidance and support. Furthermore, the admission criteria, the information provided to students, and the facilities available for students with disabilities are all satisfactory.

The panel highlights the importance of keeping a focus on AI in both programmes. Student awareness could be increased by (further) integrating AI into teaching. In addition, there are concerns with respect to workspace issues, particularly affecting MSc students within the ME faculty. The panel encourages faculty and programme management to address this issue proactively, in particular regarding dedicated places for group work and graduation work, as this also impacts student wellbeing. Also, at TUD level, the visibility of the Ombudsperson should be improved.

The panel considers the curricula of both programmes to be feasible, although actual study duration needs further attention, building upon the progress made in recent years. In the *bachelor's programme Mechanical Engineering* efforts are being made to prevent students from dropping out. The panel suggests a more thorough follow-up on the duration of studies, particularly concerning MSc theses. It supports the efforts of the *master's programme Mechanical Engineering* to address this issue, and urges the programme to establish clear guidelines for thesis completion and to track students' progress. In this context, the panel appreciates the introduction of a progress monitoring system. Additionally, it recommends improving the distribution of workload across courses and the subsequent monitoring of this workload, as well as assessing the allocation of EC for specific courses.

The panel is impressed with the quality and enthusiasm of the teaching staff of both programmes, who come from a variety of international backgrounds. They are all pedagogically qualified and are experts in their diverse fields, covering the broad academic scope of the programmes. The majority of the staff members engage in research and have strong connections with the professional and societal field through their research activities, thus providing a research-intensive environment. In addition, the panel appreciates that lecturers are dedicated and responsive towards students. In the *bachelor's programme Mechanical Engineering* the involvement of junior teachers and teaching assistants is greatly valued. The panel is of the opinion that the teacher programme is beneficial and enhances teaching methods. However, the reliance on teaching assistants presents a risk in case of future financial cuts; the panel advises the programmes to keep an eye on the effects of a reduced role of teaching assistants on staff workload. Overall, management demonstrates awareness of these challenges. According to the panel, alignment of both programmes and between MSc tracks could be improved through more structural calibration among staff members with respect to expectations on and grading in projects or master theses.

The English-taught *master's programme Mechanical Engineering* is internationally oriented, which is reflected in the international community of students and staff. According to the panel, the choice for an English name and language of instruction is well substantiated and in alignment with the international nature of the professional and academic field.

Standard 3. Student assessment

The panel concludes that the assessment system of both programmes is transparent and well designed. Adequate procedures, such as the four-eyes principle, are in place to ensure and enhance the quality of assessment. The assessment methods used are diverse and appropriate, and include assessment of skills. Amongst others, the panel appreciates the attention for constructive alignment, the standard rubrics for the literature research and MSc thesis, and the support offered by ESA.

The panel is positive about the digitalization of assessment in the *BSc Wb programme*, resulting in less administrative workload, and the exploration of adaptive testing, which allows for more efficient and personalized assessments. The Bachelor Final Project (BEP) covers all ILOs of the programme at an individual level. The panel considers the BEP assessment procedure to be well thought out, and the grades awarded to be sufficiently substantiated. Procedures, such as a logbook for project work per student and assessment of individual performance, ensure that all students individually meet the requirements for the BEP. Even so, the individual component in the BEP could be better developed. The panel recommends strengthening the BEP process, and documenting and validating individual assessments by equipping examiners with additional tools to differentiate between students. The Board of Examiners is very aware of this issue; following their recommendations, the panel encourages the programme to take further action in this regard. It also recommends offering (oral) feedback on the final BEP product. Furthermore, the panel advises to establish a learning line peer assessment; incorporating peer assessment for individual grading could promote collaborative learning among students. This approach necessitates proper training and coaching for students in feedback literacy.

The graduation project for each track covers all ILOs of the *MSc ME programme* at an individual level. The panel appreciates the set-up of the thesis project and the way it is evaluated according to uniform assessment criteria, set out in a clear rubric. According to the panel, the grades awarded are sufficiently substantiated. As for the duration of the graduation project, the panel encourages the programme to streamline processes and ensure consistency across tracks and supervisors. Furthermore, the duration allocated for the final thesis should not exceed the time associated with the assigned EC. According to the panel, establishing a clear timeline and providing more intensive guidance would help students successfully finish their thesis within 7 months. Furthermore, the panel encourages the programme to calibrate more often regarding thesis assessment, to ensure alignment and coherence between tracks.

According to the panel, the Board of Examiners proactively contributes to the quality of assessment in the programme. It has a clear task and safeguards the quality of the assessment in the programme in various ways, including the continuous evaluation of the quality of examinations.

Standard 4. Achieved learning outcomes

Based on the examination of a selection of end projects and theses from the programmes, the panel concludes that the level of the Bachelor End Projects and theses is appropriate for an academic bachelor's and master's programme, respectively. They demonstrate the achievement of the ILOs. The documentation and interviews show that alumni are generally content with the programmes and are well prepared to perform successfully in the professional field in the Netherlands and abroad.

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

Carlijn Braam MA, panel secretary

Date: 13 March 2025

Introduction

Procedure

Assessment

On 5, 6 and 7 November 2024, the bachelor's programmes Mechanical Engineering and Marine Technology of the TU Delft, and the master's programmes Mechanical Engineering, Marine Technology, Offshore and Dredging Engineering, and Materials Science and Engineering 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. Carlijn Braam acted as panel secretary in the site visit of the TU Delft.

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 27 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. They also determined that the development dialogue would be made part of the site visit. A separate development report was made based on this dialogue.

The bachelor's and master's programme Mechanical Engineering provided the coordinator with lists of graduates over the period between September 2022 and August 2024. In consultation with the coordinator, the panel chair selected 5 group projects of the BSc containing 20 students in total, and 15 individual theses of the MSc. She took the diversity of final grades and examiners into account, as well as the various tracks. For the MSc, the panel selected six theses from the track High-Tech Engineering, three from both BioMechanical Design and Multi-Machine Engineering and two from Energy, Flow & Process Technology. In addition, the panel studied one thesis from a former track, namely Vehicle Engineering (transferred to the MSc Robotics). This selection reflected the number of graduates in each track proportionally. 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 self-evaluation reports 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 self-evaluation reports and the theses, as well as the division of tasks during the site visit. The panel was also informed of 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 the draft reports based on the panel's findings and submitted them to the coordinator for peer assessment. Subsequently, the secretary sent the reports to the panel for feedback. After processing this feedback, the secretary sent the draft reports to the programmes in order to have them checked for factual irregularities. The secretary discussed the ensuing comments with the panel chair and changes were implemented accordingly. The panel then finalized the reports, and the coordinator sent them to the Faculty of Mechanical Engineering and the TU Delft.

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.A. (Maartje) Janszen BSc., master's student Mechanical Engineering at the TU Delft [student member].

The panel assessing the bachelor's programmes Mechanical Engineering and Marine Technology and the master's programmes Mechanical Engineering, Marine Technology, Offshore and Dredging Engineering, and Materials Science and Engineering at the TU Delft 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;
- 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;
- T.W.C. (Thijs) Haartmans BSc., master's student Mechanical Engineering at the TU Eindhoven [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 programmes

Name of the institution:	TU Delft
BRIN-number:	21PF
Address:	Postbus 5, 2600 AA Delft
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
Location:	Delft
Mode(s) of study:	Fulltime
Language of instruction:	Dutch
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:	BioMechanical Design Energy, Flow & Process Technology High-Tech Engineering Multi-Machine Engineering
Location:	Delft
Mode(s) of study:	Fulltime
Language of instruction:	English
Awarded degree:	MSc.
Submission date NVAO:	1 May 2025

Description of the assessment

Organization

The bachelor's and master's programmes in Mechanical Engineering are provided by the Faculty of Mechanical Engineering (ME) of Delft University of Technology (TUD). This faculty also offers the bachelor's and master's programmes Marine Technology, the master's programme Materials Science and Engineering and the master's programme Offshore and Dredging Engineering (ODE), which are all being assessed in this cluster assessment. The ME faculty also offers the bachelor's and master's programmes Technical Medicine and the master's programmes Biomedical Engineering, Robotics and Systems and Control Engineering. Until January 2024, the faculty was known as the Faculty of Mechanical, Maritime, and Materials Engineering (3mE). The new faculty name encompasses the scope and content of all research, application and education disciplines, thus strengthening cohesion in the faculty.

Recommendations previous accreditation panel

The last formal external assessment of the bachelor's and master's programmes in Mechanical Engineering of the TUD took place in December 2018. In the self-evaluation reports of the current assessment, the programmes described the actions undertaken in response to the recommendation for both programmes to investigate incentives to encourage timely progress of the students to improve the study success. In the bachelor's programme, these include adjustments to the mentoring programme and the hiring of junior lecturers to improve the student-staff ratio, as well as a planned curriculum redesign per September 2025 to enhance feasibility, coherence and relevance of the curriculum. In the master's programme, the improvements include the reorganization of the curriculum and workload, the enhancement of the introduction week for new students, and the implementation of a progress monitoring system to track student progress during their thesis work. The panel concludes that the recommendations have been seriously acted upon by the programme and is generally satisfied with the improvement measures taken.

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

Profile

The **bachelor's programme Mechanical Engineering (Wb)** aims to provide students with a comprehensive understanding of mechanical engineering principles, producing knowledgeable, flexible, independent and responsible academic engineers. The programme aims to prepare students for both advanced studies and professional careers in industry, government agencies, research and beyond. The BSc Wb offers a comprehensive and well-rounded approach, integrating fundamental principles of mechanics, kinematics, thermodynamics, control engineering and structural analysis with contemporary fields such as robotics, mechatronics, sustainable design, and materials science. The programme's orientation combines a focus on science and design with a significant practical component aimed at applying and expanding theory. Thus, the programme equips students to apply theoretical knowledge to diverse real-world (societal) challenges, while promoting critical thinking and problem-solving skills. Students participate in project-based courses, collaborating with professionals in the field of mechanical engineering. This hands-on approach is aimed at providing students with a solid foundation. As the mechanical engineering field is increasingly interdisciplinary, the link with life sciences, electrical and chemical engineering is highlighted in the

programme. The panel appreciates the focus and profile of the programme, along with its clear attention to sustainability issues and social impact.

The panel values that the BSc Wb programme has an inclusive approach, as it is the only mechanical engineering programme in the Netherlands without a numerus fixus. It also stands out as the only one offered in Dutch. There has been a steady increase in inflow from around 600 in ’18-’19 to approximately 800 in ’23-‘24. This makes it the largest BSc programme at the TUD. Students are attracted by the broadness of the programme and the career opportunities for graduates from the MSc programmes following the BSc Wb. There is also a strong connection with high tech engineering, which the panel thinks could be highlighted even more to attract prospective students. Female intake remains low, but has increased from around 10% to around 15%.

The **master’s programme Mechanical Engineering (ME)** aims to promote deep conceptual understanding of the technical fundamentals of mechanical engineering that students have been taught in the bachelor’s programme. It seeks to develop engineers who not only excel in technical proficiency but also possess a deep understanding of societal needs and environmental responsibility. The two-year master’s programme trains engineers to deal with the entire process of innovative thinking, design, manufacturing and operation, while fostering a culture of innovation and collaboration. In response to societal needs, the programme produces two types of graduates: monodisciplinary specialists with strong collaboration skills, and T-shaped professionals who are both generalists and specialists. These professionals can integrate deep fundamental knowledge on mechanical engineering with broader business and societal perspectives, and thereby increase their broader impact in the world.

The programme strives to give students a broad, in-depth understanding of most mechanical disciplines, preparing them for a range of disciplines and future careers. The panel believes that the programme has a clear focus. It offers sufficient breadth in its specializations and projects, while its depth appears to be a distinctive advantage and unique selling point. It appreciates the inter- and multidisciplinary profile of the programme and the systematic approach in which the various fields of expertise reinforce one another, as well as the attention to sustainability issues and social impact. The panel noted that compared to the other Dutch ME programmes, the TUD ME programme explicitly highlights its strong focus on building upon robust foundations in mathematics and physics.

According to the panel, the tracks of the Mechanical Engineering programme prepare students for an engineering position in a wide variety of (international) sectors. In the BioMechanical Design (BMD) track, students receive advanced education in the design and engineering of robotic devices, mechatronic design, control engineering and biological principles. This track focuses on the challenges of learning from biological systems for engineering applications. The Energy, Flow, and Process Technology (EFPT) track equips students with the theoretical knowledge, numerical and experimental skills, and practical experience necessary to develop the next generation of energy and process technologies. The track in High-Tech Engineering (HTE) educates engineers in the technological knowledge and skills they need to design a new generation of high performance products, instruments and manufacturing equipment. In the track Multi-Machine Engineering (MME), students develop the skills necessary to design integrated multi-machine systems, combining science-based methodologies, with state-of-the-art tools, and hands-on lab and industrial case experience.

The intake of students in the MSc ME programme has decreased in the past years from 354 in ‘20-‘21 to 279 students in ‘23-‘24. This seems to coincide with, amongst others, a lower number of BSc Wb students finishing their degree at the TUD, and the start of the MSc Robotics in 2020, resulting in approximately 80

students per track annually. International students constitute around 30% of the total intake for the MSc ME. The programme sees this as a positive indication of its reputation. At the same time, it aims for a sufficiently balanced international classroom and takes care that each track has a mixed student population by putting a maximum on the number of international students per track, which the panel appreciates. Since 2019, the intake of female students ranged between 14% and 20%.

Both programmes clearly stimulate students to become well-trained professionals and to be adequately prepared to continue their studies at MSc level or to conduct research at PhD level respectively. The panel values the level of self-reflection of the programmes. According to the panel, the programmes are highly responsive to developments in the dynamic field and contemporary academic and societal debates. The panel recognizes the difficulty of finding a balance between breadth and depth of the programmes in a continuously developing field.

Both programmes are well-connected to the professional field, facilitated by numerous interactions in the context of internships, graduation projects, guest lectures, study tours and contacts with alumni. Further alignment with the field is pursued per programme through the Industrial Advisory Board. The panel was pleased to learn that the Advisory Board is actively involved in the development of the programmes and advises them on developments within the domain as well as the needs of society and the professional field that are relevant to the content of the programmes. In addition, the panel notes that the professional field has a role in the current programme reforms. The professional field representatives that the panel interviewed generally feel that their input is taken into account, and indicated that they value the mutual exposure.

Intended learning outcomes
The final qualifications of both programmes are based on the Meijer's Criteria for 4TU programmes, which cover the Dublin descriptors. These criteria are defined in terms of seven broad competence areas, namely: 1) Competence in one or more scientific disciplines, 2) Competence in conducting research, 3) Competence in designing, 4) Scientific approach, 5) Basic intellectual skills, 6) Competence in cooperating and communicating, and 7) Consideration of the temporal and social context. In general, the panel is positive about the ILOs.

The **BSc Wb programme's** intended learning outcomes are spread over the seven competence areas, and describe the knowledge and skills that the programme deems essential. One final qualification was recently added to the basic intellectual skills ('to plan independently and evaluate and reflect on it in a timely manner'), as it is considered to be a valuable part of the programme that a graduate has learned to plan independently, evaluate their work and reflect on their role as engineer. The panel considers the ILOs of the BSc Wb programme to be well-defined and appropriate for the academic bachelor's level. They are formulated in accordance with the Dublin Descriptors and the domain-specific framework, and cover all relevant aspects of the bachelor's programme. At the same time, the panel noted that the ILOs contain some words that are not easy to quantify, such as elementary problems, problems of medium difficulty, and complex problems. It advises to reflect on whether this can be made more specific.

The **MSc ME programme's** intended learning outcomes are spread over the seven competence areas, and describe the knowledge and skills that the programme deems essential, with additional qualifications for each of the four tracks. The panel considers the ILOs to be appropriate for the academic master's level. They are in accordance with the Dublin Descriptors and the domain-specific framework, and cover all relevant aspects of the master's programme. Furthermore, the ILOs are in line with the BSc Wb programme, which makes transition from one to the other logical. However, the panel noted that the 'consideration of the

temporal and social context' could be made more explicit, for instance by specifically mentioning consideration of sustainability.

Considerations

Based on the reviewed documents and discussions during the site visit, the panel concludes that the **bachelor's programme Mechanical Engineering** has a clear profile, providing students with a comprehensive understanding of mechanical engineering principles, while integrating fundamental principles with contemporary fields. The panel appreciates the hands-on approach and the focus on applying theoretical knowledge to diverse real-world challenges, while stimulating critical thinking and problem-solving skills.

In addition, the panel concludes that the **master's programme Mechanical Engineering** has a clear focus, providing in-depth knowledge of mechanical engineering fundamentals, while promoting environmental responsibility and societal perspectives. The panel appreciates the multidisciplinary profile of the programme and the interaction between the various fields of expertise, as well as the different tracks. Students are prepared for diverse engineering roles in various sectors as both generalists and specialists, who are capable of integrating technical knowledge with broader contexts.

The panel is also positive about the interdisciplinary link with life sciences, electrical and chemical engineering, as well as the explicit attention for sustainability issues and social impact in **both programmes**. Furthermore, the programmes are very attentive to contemporary academic and societal questions, due to their strong connections with the professional and societal field. The panel considers the ILOs to be appropriate to an academic bachelor's and master's level respectively, and in alignment with expectations in the academic and professional field.

Conclusion

The panel concludes that the bachelor's programme Mechanical Engineering meets standard 1.
The panel concludes that the master's programme Mechanical Engineering meets 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

The **BSc Wb programme** consists of 180 EC and is offered as a fulltime three-year programme. The curriculum is composed of three key components: basic science (mathematics, physics, thermodynamics); engineering courses (solid and fluid mechanics, dynamics, control) and design projects, where knowledge can be integrated, and technical and transferable skills are trained (evaluation and presentation techniques). The curriculum aims to provide students with a broad, in-depth understanding of a selected set of mathematics and all mechanical engineering disciplines throughout the first and second year. In addition, students acquire the ability to deal with the entire process of mechanical design engineering. They also learn to perform research and design on mechanical engineering topics at an academic level. All projects, including the Bachelor End Project (BEP), are devoted to current technological issues in society and science. Most course modules require a nominal effort of 6 EC, with the exception of the Ethics course (4 EC) and the

Bachelor End Project (14 EC) at the end of the 3rd year. The first half of the 3rd year comprises a minor of 30 EC, as in all TUD BSc programmes. The minor contains the elective space of students in the programme; they can compose an individual minor or they can choose from a variety of minor offers from TUD or other universities. In the third year, the course 'Integrated Mechanical Systems' serves as a capstone by connecting courses from the first and second years. The Ethics course 'Engineer in Society' contains theory of engineer's ethics and requires students to write an essay on the ethical implications of their BEP topic.

The Bachelor End Project (BEP) has the character of a graduation project and is scheduled as a 14 EC course. The BEP runs over an entire semester, with 3 EC in the first and 11 EC in the second quarter. It is carried out in teams of four students at one of the seven research departments of the faculty. To facilitate students and distribute workload for staff and laboratories, the BEP is organized each semester. Students have some flexibility to select their preferred department: each department provides a sufficient number of BEP-project proposals, and once allocated to a department, students can indicate a preference for a project. The BEP coordinator of the department arranges the division into teams and the assignment to daily supervisors, who are members of the scientific staff of the relevant department.

Based on the documents, the panel noted that the 'consideration of the temporal and social context' is not very visible in the programme apart from one non-technical (ethical) elective course (which is mandatory in every MSc programme) and should be made more explicit. During the interviews, the panel learnt that sustainability issues and social impact are addressed as part of several courses and lectures on for example circular economy and ethics, as part of the BEP, as well as in the form of a 'green award' for first-year students (application in projects). As responsible teachers educate responsible engineers, teachers play an exemplary role by incorporating sustainability into their work. The panel appreciates this emphasis. During the site visit, the panel also discussed the attention for transferable skills in the programme. Both teachers and students are of the opinion that there is a good balance between hard and soft skills. In the first year, there are four design projects of 6 EC each, in which students' writing and public speaking skills are assessed, amongst others. According to the professional field representatives, these projects are a positive element of the programme; they add to the practical experience and contribute to the acquisition of skills by students. Students appreciate the breadth of the programme and its emphasis on practical applications during projects, providing them with hands-on experience. In group work, they are challenged to take up various roles, although they mention that this often proves to be difficult. The panel suggests that offering training in collaborative work and group management at the start of projects could enhance team dynamics, and help tackle the issue of free riders, which according to the students, can be a problem during group work in the first year. It concludes that the first-year projects are more focused on individual skills than on collaboration and team work, although these are mentioned in the ILOs.

The panel considers the curriculum of the **BSc Wb programme** to be well-structured and coherent, with strong links between the courses. The curriculum covers all ILOs, as is demonstrated in the tables included in the self-evaluation report. The design of the curriculum makes sure that courses build upon each other in terms of knowledge and skills. The design projects are particularly appreciated.

The current curriculum aimed to streamline the learning process through various learning lines and a standardized study load for each period (15 EC), with 'vertical' modules of 6 EC. The modules are mainly delivered by one of the faculty's research departments. Over the last few years, small adjustments have been made to include more emphasis on specific fundamentals (materials science and mechanical systems) and on soft skills, and to improve student guidance. Students indicated to the programme management that these adjustments have added up to disparities in study load across periods. Also, the vertical structure of different topical domains is not optimal for knowledge retention within specific domains.

Therefore, the programme has been working on a renewal of the curriculum, to be likely implemented in the academic year 2025-2026 (year 1). The main goals of the renewal are to enhance the feasibility, coherence and relevance of the curriculum, while ensuring alignment with the faculty's educational vision (in the bachelor's programmes, the emphasis is on the transition to an independent, responsible and motivated student as well as the acquisition of academic skills). The programme strives for, amongst other things, a higher binding study advice (BSA) pass rate by preventing a false start in the first period; improved study progression through a well-distributed workload; an early emphasis in the curriculum on programming education, numerical mathematics, and modelling; and continued focus on fundamentals with integrated skills learning lines for design, manufacturing, materials science, and digital skills (including AI), as well as for transferable skills, ethics, and sustainability. It also addresses contemporary developments, such as AI and the energy transition. Additionally, the writing skills of bachelor students, both in English and Dutch, deserve more attention. The new curriculum also intends to support knowledge retention through horizontal (semester-wise) modules ('learning pillars'), and by providing theory courses just before the application projects. An initial step in this direction has been implemented in September 2024: two challenging fundamental modules ('Advanced Mechanics' and 'Fluid Mechanics & Heat Transfer') run concurrently throughout the semester. Moreover, more research departments will be involved in the programme, by allocating space for elective courses. The update of the curriculum is executed in consultation with the programme director of the Maritime Technology bachelor's programme, as some Wb courses are shared with the BSc MT.

The panel is positive about the curriculum reform. It endorses the fact that it addresses a variety of issues, feasibility in particular, also through improvements in the scheduling of courses, and that all skills will be integrated in the courses. According to the panel, the development of the programme is done with great care. The panel appreciates that input from the professional field is explicitly taken into account in the renewal process. In addition, an international benchmark study was conducted with a focus on how other institutions incorporate professional skills in their BSc mechanical engineering programmes.

Students indicate that, although they are not directly involved in the renewal of the programme, their feedback is taken into account. For example, after feedback of last year's students, some adjustments were made this academic year. These have resulted in a more evenly distributed work load in year 2. Students are pleased with the changes and the responsiveness of programme management to student's feedback. However, students would like to receive more clear communication from the programme about the upcoming curriculum changes and their impact. Until now, their main source of information is the study association. The panel agrees that the programme should inform students more about the intended curriculum changes and how they will affect them.

The **MSc ME programme** consists of 120 EC and is offered as a fulltime two-year English language programme, structured into eight quarters of 15 EC. The curriculum builds upon the foundational knowledge and skills from the BSc ME programme. The MSc ME programme consists of four tracks of specific disciplines within the field of mechanical engineering, strongly based on the available research expertise: BioMechanical Design (BMD), Energy, Flow and Process Technology (EFPT), High-Tech Engineering (HTE) and Multi-Machine Engineering (MME). All tracks require entrees to have a BSc ME-equivalent background. In addition, for international students grades, motivation and proficiency of English are taken into account. Based on these, the track coordinator provides admission advice to the central International Office of the TUD. Students select a track immediately at the start of the programme. The panel learnt that each track contains a range of mandatory courses (choice from 11 core courses) and optional track specific courses in the first year.

Students decide on their Individual Study Programme (ISP) with the help of the track coordinator of their track. They are also obliged to take a non-technical course of 3-6 EC. This can be related to for example climate, entrepreneurship or ethics, to put engineering skills into a broader societal context. In recent years, the MSc programme has been harmonized between the tracks. All tracks offer a selection of core ME courses in combination with specialization courses and follow the same final year structure. This mandatory ME core was introduced in 2017 to ensure a certain degree of overlap between all tracks within ME. The core was adapted in 2019 and supplemented with 5 EC of elective space. In 2022, a new improvement of the core focused on relevance, flexibility, and feasibility. The current structure is evaluated positively by students, as well as by the panel; it appreciates the very flexible programme that can meet different types of student expectations. According to the panel, there is an opportunity to enhance the integration both of a broader perspective and of soft skills, including attention to ethics, into the compulsory (technical) courses, similar to the integration of sustainability topics.

Across all tracks, the second year of the programme consists of three elements: a 15 EC (interdisciplinary) project, a research assignment or an internship; a literature survey or problem definition; and an individual thesis project. To enhance uniformity across the faculty, a 15-10-35 study load of the three elements has been implemented. In line with the TU Delft guidelines, the first quarter of the second year is available for internships, multidisciplinary projects or free electives (15 EC). Interdisciplinary activities include the TUD Joint Interdisciplinary Project (JIP) or thesis assignments in close collaboration with medical or environmental professionals. Some tracks include an external internship, while other tracks choose to let the students work on a research assignment in-house, or offer the internship as an elective. The research assignment is a short project linked to the research of a staff member, during which students can develop their own research skills under the supervision of the staff member. During the literature survey students independently search for recent scientific publications. For most tracks, the topic of this study is linked to the graduation project. The student's findings from the literature survey are used to motivate the research plan that is summarized and presented in a colloquium. MSc students can select from a wide range of graduation projects, such as laboratory experiments, modelling and simulation, design and prototyping, or a mix of these. Students work on a complex problem, and develop new theory or design methods to solve complex mechanical engineering problems. The graduation project is always connected to the research area of the supervisor. It can be carried out within one of the labs in the faculty or at an affiliated faculty, but also within a company, within a research institute or at another university, which are carefully selected. Students have regular meetings with their supervisor, who is a scientific staff member of a ME department or an affiliated faculty. When they do their graduation project externally, they also have a daily supervisor at the company, institution or external organisation involved.

The panel learnt that most students do not opt for an internship, and that this is often also not actively encouraged by teaching staff members. Most feel that as students often do their graduation project in collaboration with industry and get to experience the working environment here, there is no need for an additional internship. The panel understands this, but also notes that an internship of several months can promote students' professional skills development, which are included in the ILOs, more than an academic project. It emphasizes the need to clearly explain to students what an internship involves and how the learning objectives will be achieved during the experience.

The panel considers the curriculum of the **MSc ME programme** to be well-structured and coherent, with strong links between the courses. The curriculum covers all ILOs, as is demonstrated in the tables included in the self-evaluation report. The design of the curriculum makes sure that courses build upon each other in terms of knowledge and skills.

The panel appreciates how **both programmes** continually reflect on the content of the curricula in light of the professional and academic field. This responsive attitude is also reflected in the ongoing incremental changes implemented in the courses.

The panel observes that in general, every course is evaluated once every three years. This evaluation, as well as individual feedback from students, serves as a signal for lecturers. At the end of each quarter the study load, amongst others, is assessed through a survey. In addition, midterm panel discussions are arranged with the study associations to collect feedback during each quarter. On the basis of these evaluations, actions are planned and taken. The results and follow-up of evaluations are reported to the study associations, which relay this information to the students. The panel values the formal and informal evaluation of courses. Yet, based on signals from students during the interviews, it recommends that the programmes place greater emphasis on responding to student feedback. For instance, at the beginning of each course, last year's feedback and follow-up steps could be shared with students.

The Education and Student Affairs (ESA) department is currently enhancing its use of various evaluation data for monitoring purposes, supported by a recently implemented dashboard. The panel supports this development, as it thinks that the current PDCA (Plan-Do-Check-Act) cycle, the check and act phases in particular, could benefit from a more structural approach. This includes for instance formulating explicit goals, determining the necessary steps to achieve these and monitoring the impact of measures. According to the panel, the ILOs should be the basis of this approach: all improvements should ultimately contribute towards equipping students better to achieve the learning outcomes. It recommends the programmes to continue onto the path of structural use of evaluation data. To aid programme directors in the continuous improvement of the programme, the panel suggests that their attendance at Board of Studies meetings be established as a standard practice.

Learning environment
Following the faculty's vision on education, the programmes strive to offer students a student-centred learning environment, where they take responsibility for their own learning and development as engineers (self-leadership). This occurs in dialogue with developments in society. Design-based learning is therefore integrated into the educational concept of the reflective engineer. In the (multi- and interdisciplinary) project-based education, students learn to apply knowledge, design, collaborate in (international) teams, and find solutions to societal challenges.

In the **BSc Wb programme**, hands-on experience through practical projects is emphasized, equipping students to apply theoretical knowledge to real-world engineering challenges. The panel appreciates that in the first year, a community feeling is stimulated in the large cohorts; students are divided in clusters of 50 to 64 students for tutorials and most courses. During tutorials, the focus is on application of knowledge and interactive discussions, so that students can learn from each other. While the tutorials are not compulsory, teachers make an effort to encourage student attendance and notice a positive trend this year. The programme is aware of attendance issues, which are thought to be influenced by cultural factors, as it proves to be difficult to motivate students to come to campus and engage actively. The panel endorses the efforts made to improve attendance. It believes that group work and the associated peer learning can serve as valuable tools in promoting an on campus culture. Efforts to enhance on-campus engagement and the introduction of tests to improve attendance are seen as positive steps.

The design education in the BSc ME teaches students linear methodologies such as CDIO (Conceiving, Designing, Implementation, Operation). In the master tracks challenging design tasks are included, which also predominantly use the linear approaches to design. The programme is looking into ways to improve the

exposure to a range of design methods such as Agile/Scrum, in addition to a few MSc courses. By integrating various design methodologies and encouraging interdisciplinary collaboration, students can develop a more comprehensive approach to problem-solving and explore creative solutions.

In the **MSc ME programme**, the smaller group sizes for each track promote a personal approach and an equitable distribution of roles during group work. The different backgrounds of both students and staff bring various perspectives and experiences and foster cross-cultural collaboration, which reflects the globalized nature of the field and promotes integration. Additionally, the programme provides flexibility for students in developing their own profile, which is appreciated by the students.

The courses combine lectures with tutorials (BSc ME), assignments and design-oriented individual or group projects. Throughout the courses, students work individually and in small groups to train working both independently and within a team. The staff is supported by teaching assistants who can be consulted by the students. The panel values the student centredness of **both programmes** and is positive about the learning environment. It is of the opinion that the programmes offer varied teaching methods including guest lectures to introduce students to different perspectives, and an adequate balance between theoretical knowledge and practical skills. The panel notes that while the existing AI policy is clear, there is an opportunity to enhance student awareness of it, for example by (further) integrating AI into teaching, to educate students on the use of AI as a tool.

The panel observes that the facilities available are of a high standard, encompassing state-of-the-art equipment, labs and computational resources for teaching and research. Students have access to the education facilities in the ME faculty and other locations on campus. Yet, the increase in student enrolment at the faculty in recent years, especially in the BSc ME programme, and the accompanying increase in academic staff, has resulted in limited spaces for both students and staff. Bachelor students do not experience too many issues, as they have dedicated rooms for project work. However, master students, who are embedded in the department, have a hard time finding workspaces for individual as well as group work; rooms need to be booked in advance but are often not available. The programmes try to accommodate students as much as possible, by opening up lecture halls when these are not used for lectures. While some staff provide spaces for students, this is not a common practice. Faculty management acknowledges the problem and has discussed the infrastructure issues with the executive board. It anticipates that the situation will improve by April 2025, at which point office spaces will be reallocated. Meanwhile, the panel urges faculty and programme management to address this issue proactively, in particular regarding dedicated places for both group work and individual graduation work, since a lack of workspaces could have a negative impact on student wellbeing.

Feasibility

The **BSc Wb programme** aims to attract Dutch students with a vwo-degree including mathematics-B and physics, or with a relevant propaedeutic degree from a university of applied sciences, as well as international students (mainly from Belgium, Germany, the Scandinavian countries and Suriname) with a similar background, after having passed an entrance level test in Dutch language proficiency. The panel recognizes that the programme is well aware of the challenges related to a large student population with different abilities and motivations. The programme has a significant drop-out rate in the first year of about 50%, which the programme attributes to the absence of a mandatory selection procedure: most students that drop-out mention different expectations as the main reason. There are several personal factors contributing to the drop-out, including a lack of motivation. First-year students receive an advice whether they can continue their studies based on their binding study advice (BSA) prognosis in March. Those students likely to get a negative BSA are advised to contact the academic counsellor. After the first year, there is a drop-out of only

2%. The significant drop-out rate in the first year also impacts group work. Some students drop out early; others continue their group work but skip courses. The students informed the panel that the controlled formation of project groups is beneficial for them, which is a pilot this year. They appreciate that attending tutorials can lead to a better grade (bonus/malus score). According to students, mandatory attendance for certain programme components in the first year would also help study progress.

The panel concludes that the BSc Wb programme is doable in 3 years for students who are sufficiently motivated. However, many students take longer, 4 or 5 years, to complete their studies. Among first-year students, approximately 64% progress to their second year (not counting those who dropped out before February). From this cohort, about 41% earn their diploma within four years. The programme is pleased with this outcome, as it represents an improvement over previous years, showing that the measures taken in response to the previous accreditation were successful. Nonetheless, further options are being explored to prevent students from dropping out and to manage student expectations. The panel encourages the continued effort on this topic by the programme.

The **MSc ME programme** aims to attract Dutch students with a BSc degree from a university, Dutch students with a BSc degree from a university of applied sciences, and international students from inside and outside the EU. The programme is well connected to the BSc ME programmes in the Netherlands. For students who do not have a bachelor ME, there are several admission requirements. International students are required to have an academic BSc degree in the same or a closely related discipline, and adequate English proficiency. A bridging programme is in place for those who do not comply with the admission criteria.

The panel was informed that during the introduction week, MSc ME students receive an overview of the workload associated with the courses. A total of 54 EC is required to start with the graduation project, as mandated by university policy, with daily supervisors assigned to monitor student progress. The programme has had a lower than average drop-out rate (below 15%) in the past years. Despite efforts to improve the study duration, only 45% of MSc ME students graduate within 3 years. Typically, non-EU students complete the programme in two years, while EU students take a few months longer, and Dutch students on average take the longest. This discrepancy has been a long-standing issue. Among MSc students, there are concerns about workload distribution. This is particularly the case in the High-Tech Engineering (HTE) track, where there is often a heavier workload at the end of the academic year for the same number of EC. While the study load is deemed manageable within two years, some courses are perceived as requiring more effort than others, leading to an imbalance between courses and quarters.

Additionally, the length of the graduation project was discussed. The panel learnt that the literature survey and thesis project, which together amount to 45 EC, typically require about 9 months to complete, although Dutch students in particular may take longer, partly due to additional commitments; they do not face the same pressure as international students to finish their thesis in time. The panel notes that in principle, 45 EC should not exceed approximately 7 months, and exceptions should not be supervisor-dependent. The programme recognizes this issue and is testing various strategies to motivate students to complete their work on schedule, for example with a midterm review that is part of the grade. The panel believes that it is crucial to support students in completing their work in time and monitor this. In this regard, it is positive that a progress monitoring system (MyCase) is currently being implemented to track student progress during their thesis work and offer targeted support. The panel highlights the need for greater focus on time management skills, especially during the MSc thesis. The industry also pointed out that these skills are crucial and require enhancement among current graduates.

The panel concludes that the feasibility of **both programmes** is appropriate, but actual study duration needs further attention. The programmes have made progress since the previous accreditation, but need to continue onto this path for further improvement. The panel suggests a more thorough follow-up on the duration of studies, particularly concerning MSc theses. It is important to establish clear and uniform guidelines for thesis completion. The panel acknowledges that there is a system in place (Evasys) for monitoring the workload for each course. Still, it recommends improving the monitoring of workload across courses and academic quarters, as well as reassessing the allocation of ECs for certain courses with respect to their workload. Since any changes to the workload of courses must be submitted by March for implementation in the subsequent academic programme, it is essential to promptly follow up on student feedback.

Guidance
The panel views the guidance provided to students during both programmes and the accessibility of programme-specific services and facilities positively, providing ample opportunities for the development of an academic community. In the **BSc Wb programme**, these include an introductory weekend for new students organized by the study association, plenary information sessions for all study years and various other activities, such as extra study support for resits. The panel particularly values the mentoring programme for first-year students, which the programme has introduced in the first 2.5 quarters. In this programme, senior BSc and MSc students act as student mentors for project groups to assist first-year students in adapting to the academic environment. The programme includes, amongst others, group activities, attendance monitoring, regular study assignments, and tutorial classes. The student mentors also organize social activities for the project groups to enhance group cohesion. Students receive extensive support from teaching assistants as well as their mentors. Additionally, the panel appreciates the hiring of an education advisor in 2022 with a focus on student support to further improve and coordinate the mentorship programme, as well as the mandatory training mentors receive beforehand to prepare them for their diverse responsibilities. It was informed that in the future, the roles of mentoring and project team guidance that the student mentors currently have, will be disentangled to strengthen the mentoring programme.

During the first year, there are weekly cluster meetings (consisting of 8 project teams with 4 student mentors), guided by a cluster project teacher who is primarily responsible for monitoring progress, aligning teaching activities and giving technical feedback. Most other teaching activities during the first year, including mathematics and fundamental courses, are organized per cluster as well. This changes in the second and third year of the Wb-programme, where mathematics and fundamental courses are taught in plenary sessions and students are expected to take their own responsibility in organizing study groups. Student performance is monitored and supported by the mentorship programme and a performance feedback system.

During the site visit, the panel learnt that the programme sometimes struggles with a proper social interaction in group work among students. In particular, female and international students can feel lost and unsafe in the culture of blunt communication and disrespect among students. The programme acknowledges this issue and has employed a full-time staff member to enhance social safety, with a focus on fostering positive interactions among students. The panel appreciates that the study association takes up an active role in this as well. At the same time, the panel noted that students do not always feel comfortable reporting issues to their mentors. The panel understands this and feels that this issue goes beyond the responsibility of the student community and needs to be addressed on a programme level. Therefore, the panel urges the BSc programme to increase awareness and keep taking proactive measures to ensure a socially safe environment for all students. In addition, the panel advises the TUD to improve the visibility of the Ombudsperson for students, who can provide impartial advice, mediate between parties, refer to other forms of support, or initiate an independent investigation if necessary. Despite various attempts to raise

awareness about the existence and role of the Ombudsperson, students remain unfamiliar with the concept. The panel commends the initiative to establish a reporting point for students and staff at the university level by the end of 2024.

In the **MSc ME programme**, the introductory week has been recently enhanced. During this week, students are introduced to the department of their track, including staff, research projects, labs, and study associations. Also, according to the programme, monitoring and guidance mechanisms have been improved. The track coordinator supports students in deciding on their Individual Study Programme (ISP) and advises them on the course selection appropriate to specific thesis topics and supervisors. Navigating course selection is generally more straightforward for students who completed their bachelor's degree at the TUD. Meanwhile, the programme offers the flexibility to change tracks later; switching tracks is not uncommon, allowing for a more tailored educational experience as interests and career goals evolve. Students informed the panel that the start of the first year can be quite overwhelming. However, they feel well-supported and value the orientation week, the comprehensive study guide, and the extra assistance from the study association.

The daily coordinator is the first point of contact for students. They are easily accessible for students and if needed, can refer them to one of the seven study advisors at faculty level. Additionally, there is a mentorship system for first-year MSc students, which is appreciated by students. Depending on the department, senior students or staff members serve as mentors. Students indicated to the panel that some tracks do not include mentors. The panel sees the availability of dedicated student mentors as a good practice and example for other tracks, and advises to use mentors in all tracks. In the graduation year, the project supervisor is the primary contact, who can involve the coordinator if necessary.

Academic counsellors play a key role in referring BSc and MSc students to the right resources. For example, students with mental health issues can see student psychologists or attend training sessions on personal well-being. Furthermore, the panel noted that the study association takes an active role in supporting students to find their way, amongst others by organizing a variety of academic and social activities. The association is also actively involved in advisory bodies such as the Board of Studies, which is responsible for the quality assurance of the ME study programmes. Apart from Gezelschap Leeghwater at the faculty level, each master programme also has a dedicated study association, as do all the tracks within the MSc Mechanical Engineering.

The panel acknowledges that **both programmes** effectively provide information to students through the digital learning environment Brightspace in an accessible and timely way. This platform also features tools like Buddy Check. Additionally, the programmes consider the needs of all students, including those with functional impairments. In alignment with the TUD Note on "Duty of Care", this includes personal and/or separate provisions such as extra time for exams or separate exam settings, and adjusted schedules.

Teaching staff

The teaching staff in the **BSc Wb programme** mainly have backgrounds in technical or natural sciences. The staff includes 9 full professors, 10 associate professors, 1 assistant professor and 2 teachers. A significant portion of the teaching and support staff is of international origin. Mathematics courses are taught by staff from the Delft Institute of Applied Mathematics (DIAM). In addition, the programme is aided by project support teachers from the industry. In the student chapter, the panel observed a consensus among students that there is limited interaction with the professors, although during the site visit, students emphasized the involvement and availability of teachers. To improve the student-to-staff ratio (40:1 in 2019) and given the fact that new staff in the faculty are often not Dutch speakers and not quickly available for (co-)teaching in

the bachelor, the ME faculty introduced junior teachers in 2020. The panel appreciates that the staff has been increased with the hiring of junior teachers, who are involved in tutorial classes in the first year, specific lab classes in all three years of the BSc-programme, and in some MSc-courses, as well as in providing instructions to teaching assistants. They are appointed for three years and dedicate half of their time to obtaining a first-degree teaching qualification to become a secondary school STEM-teacher, while working in the faculty for the other half. The panel learnt that there are around 20 junior teachers in total for the seven departments. The programme considers their presence to be very helpful and intends to give them more of a mentoring role in the coming years. Additionally, the staff is supported by teaching assistants, typically MSc or PhD students, for the grading of first-year and some second-year written exams, under the guidance of the professor responsible. The panel is positive about the involvement of teaching assistants and junior teachers. It sees the teacher programme as beneficial, enhancing student-staff interactions as well as didactic skills among educators. However, it observes the potential risk of future funding cuts and the possible impact this may have on teachers' workload. It was reassured by faculty management that decreasing finances will not affect junior teachers. Yet, the use of teaching assistants will be reduced to the first BSc year, at this stage, thus affecting the MSc programme. In addition, 'grading factories', where a selected group of teaching assistants collectively grade written exams under the guidance of the professor responsible, will no longer be used in the BSc programme. The panel advises the programmes to keep an eye on the effects of a reduced role of teaching assistants on staff workload.

The **MSc ME programme**'s staff come from diverse fields, including Mechanical Engineering, Physics and Mathematics. The staff includes 19 full professors, 43 associate professors, 38 assistant professors and 3 teachers. They all engage in research and actively contribute to the development of their disciplines, as do most of the BSc staff members, often teaching in one or more master's programmes as well. The faculty is recognized for its scientific excellence, which the programme views as one of its key strengths. Students appreciate that lecturers incorporate examples from their own projects during class, as this helps to expand their perspectives. Recent additions include tenure-track assistant professors who are initially involved in smaller courses under the guidance of experienced staff. The programme values international perspectives, with one-third of the staff being international, many fluent in Dutch. Almost all staff is involved in supervising students. Currently, the staff is supported by teaching assistants (MSc or PhD students) who can be consulted by the students and check the homework assignments. The programme management meets every four weeks to discuss ongoing matters and ensure alignment between the tracks. As the track teaching teams are quite small, the master coordinators mostly update them informally. The panel recognizes the importance of the track coordinators, since they play a crucial role.

In the interviews, the panel has seen experienced, well organized and engaged teams that cover the academic scope of **both programmes**. All primary responsible lecturers hold PhDs, aligning with faculty policy. The lecturers have strong connections with the professional and societal field through their own research activities, providing a research-intensive educational programme. In addition, the panel appreciates that lecturers are dedicated and responsive towards students. Moreover, the professional field values the drive and positive attitude of the staff, who are very motivated to improve the programmes. The panel notes with appreciation that teaching quality is ensured through an academic development policy that focuses on both teaching and research qualifications. All responsible lecturers (or most, in the MSc programme) have completed their University Teaching Qualification (UTQ), and new staff members are required to complete the UTQ within three years. An Education Day is organized twice per year for all faculty teaching staff, where the latest developments in education and in professional practices are discussed.

Internationalization

The **MSc ME programme** has an inherently international orientation, as the mechanical engineering field has a global character and increasingly international labour market. The panel approves of the choice and underlying argumentation for an English name and language of instruction. According to the panel, this aligns well with the international nature of the professional and academic field. Through the international focus, students are exposed to different perspectives and gain experience in collaborating within international teams. Thus, they are prepared for working in an international context.

The diverse background of both teachers and students supports a globally oriented educational environment. The university has adequate professionalization policies in place for ensuring lecturers' proficiency in English. Students with international prior education must demonstrate proof of English-language proficiency. The panel appreciates the opportunity for students to follow part of the programme abroad. It is also positive about the attention to intercultural collaboration, and the careful monitoring of English proficiency levels of both staff and students.

Considerations

The panel considers the curriculum of both programmes to be well-structured and coherent. The **bachelor's programme Mechanical Engineering** addresses transferable skills through design projects, focusing on both individual and collaboration skills, although first-year projects tend to focus more on individual skills than team work. The panel values the emphasis on practical applications during projects, and the additional opportunities for research involvement during the Bachelor End Project (BEP). According to the panel, the **master's programme Mechanical Engineering** offers sufficient breadth in its specialization and projects, while its depth seems a distinctive advantage and unique selling point. It appreciates the inter- and multidisciplinary content of the curriculum, as well as the mandatory core per track. The panel concludes that sustainability and social impact are well integrated into the curricula, although the integration of a broader perspective and of soft skills, including attention to ethics, into the mandatory MSc ME curriculum (technical courses) could be enhanced. The curricula cover all ILOs and provide students with a comprehensive foundation in mechanical engineering.

The panel appreciates how the curricula are continuously updated in response to developments in the professional and academic fields. The panel supports the planned curriculum reform for the **bachelor's programme Mechanical Engineering**, noting its potential to enhance feasibility and relevance in response to contemporary challenges such as AI and energy transition. However, the panel advises the programme to be more transparent to students about the impending changes and to keep an eye on the flexibility offered to students. In addition, for **both programmes**, there is a need for improved monitoring through the PDCA (Plan-Do-Check-Act) cycle, particularly in relation to the connection with the ILOs. To facilitate this process, the panel believes that the role of programme directors could be strengthened. While it values the formal and informal evaluation of courses, the panel is of the opinion that more attention could be paid to include monitoring data with, amongst others, study progress, student number evolutions and course success rates, and by providing feedback on students' feedback.

The panel is positive about the student-centred learning environment of **both programmes**, providing opportunities for the development of an academic community, and the active role of the study association. The courses offer varied teaching methods, with a focus on challenge-based learning and (multi- and interdisciplinary) project-based education, and an appropriate balance between theoretical knowledge and practical skills. According to the panel, students are well-supported throughout the programmes. In the **bachelor's programme Mechanical Engineering**, the panel particularly values the mentoring programme for first-year students and the organization of student groups in clusters, fostering a sense of community.

The panel believes that group work and the associated peer learning can serve as valuable tools in promoting an on campus culture. There are, however, concerns regarding social safety among students, as more systematic measures need to be implemented. The panel urges the BSc programme to increase awareness of this issue and to take proactive measures to ensure a socially safe environment. In the **master's programme Mechanical Engineering**, track coordinators play an essential role in advising students on their Individual Study Programme (ISP). Further support is provided to first-year students through daily supervisors and a mentorship programme, as well as by project supervisors during their final year. The panel describes the dedicated student mentors in some tracks as a good practice. The panel concludes that all students receive adequate guidance and support. Furthermore, the admission criteria, the information provided to students, and the facilities available for students with disabilities are all satisfactory.

The panel highlights the importance of keeping a focus on AI in **both programmes**. Student awareness could be increased by (further) integrating AI into teaching. In addition, there are concerns with respect to workspace issues, particularly affecting MSc students within the ME faculty. The panel encourages faculty and programme management to address this issue proactively, in particular regarding dedicated places for group work and graduation work, as this also impacts student wellbeing. Also, at TUD level, the visibility of the Ombudsperson should be improved.

The panel considers the curricula of both programmes to be feasible, although actual study duration needs further attention, building upon the progress that has been made in recent years. In the **bachelor's programme Mechanical Engineering** efforts are being made to prevent students from dropping out. The panel suggests a more thorough follow-up on the duration of studies, particularly concerning MSc theses. It supports the efforts of the **master's programme Mechanical Engineering** to address this issue, and urges the programme to establish clear guidelines for thesis completion and to track students' progress. In this context, the panel appreciates the introduction of a progress monitoring system. Additionally, it recommends improving the distribution of workload across courses and the subsequent monitoring of this workload, as well as assessing the allocation of EC for specific courses.

The panel is impressed with the quality and enthusiasm of the teaching staff of **both programmes**, who come from a variety of international backgrounds. They are all pedagogically qualified and are experts in their diverse fields, covering the broad academic scope of the programmes. The majority of the staff members engage in research and have strong connections with the professional and societal field through their research activities, thus providing a research-intensive environment. In addition, the panel appreciates that lecturers are dedicated and responsive towards students. In the **bachelor's programme Mechanical Engineering** the involvement of junior teachers and teaching assistants is greatly valued. The panel is of the opinion that the teacher programme is beneficial and enhances teaching methods. However, the reliance on teaching assistants presents a risk in case of future financial cuts; the panel advises the programmes to keep an eye on the effects of a reduced role of teaching assistants on staff workload. Overall, management demonstrates awareness of these challenges. According to the panel, alignment of **both programmes** and between MSc tracks could be improved through more structural calibration among staff members with respect to expectations on and grading in projects or master theses.

The English-taught **master's programme Mechanical Engineering** is internationally oriented, which is reflected in the international community of students and staff. According to the panel, the choice for an English name and language of instruction is well substantiated and in alignment with the international nature of the professional and academic field.

Conclusion

The panel concludes that the bachelor's programme Mechanical Engineering meets standard 2.
The panel concludes that the master's programme Mechanical Engineering meets standard 2.

Standard 3. Student assessment

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

Findings

Assessment system

Assessment in the programmes is aligned with the Education and Examination Regulations and the educational vision of the TUD as well as the faculty, embracing the constructive alignment principle of education. This includes a combination of formative and summative assessment in each course, with a gradual reduction in the number of formative tests as students take greater control of their own learning. The faculty aims to adjust and align its quality assurance handbook and assessment policy with the TUD assessment framework, published last year, by the end of 2024. In programme-specific assessment plans, all assessments and courses are aligned with the ILOs of the programmes. The panel observes that there is a well-defined university-wide assessment policy and sufficient standardization, for example through standard rubrics for the literature research and MSc thesis. Also, students are properly informed about the examination procedures and assessment criteria.

In the **BSc Wb programme** ILOs are assessed based on a variety of assessment methods, including oral and written exams, individual and group exams, in the form of practical assignments, digital assessment, projects, and mandatory lab sessions. Assessments are mostly summative with formal formative testing mainly done in the first year. Every course or project unit contains at least one summative test at the end of each quarter; some courses have online formative self-assessments. Additionally, the programme is exploring the potential for future implementations of adaptive testing, which allows for more efficient and personalized assessments for large groups of students. The panel is positive about this evolution and characterizes the assessment in the programme as well thought out. It also appreciates the general meeting at the beginning of a BEP-semester of all departmental BEP-coordinators with the programme management to exchange best practices, and monitor consistency in workflow and processes between departments, for instance regarding the grading rubric. Another advantage is the creation of an online platform designed to improve the efficiency of reviewing written assignments. This tool enables lecturers to create and assess exams digitally as well as on paper and has led to less administrative workload, saving time for the feedback process. Furthermore, exams can be conducted on students' personal laptops (BYOD) or on TUD computers; the current hybrid situation is partly solving the capacity challenges.

The panel was informed that in every project, several skills are assessed individually, such as programming, reporting and presenting. For group work, the Buddy Check tool is used, where mentors evaluate team skills with the groups and individual students. They discuss this with the project teacher who gives a grade per group, but also differentiates when necessary. To prevent free riding, mentors keep track of students' participation, although the panel sees potential for enhancing collaboration skills in first-year projects. The panel advises to establish a learning line peer assessment, while noting that it would not advise using peer reviews (Buddy Check) in the first quarter nor before prior peer reviewing training. It is a large responsibility for mentors to evaluate students' skills, despite the tools and trainings they receive.

The **MSc ME programme** also employs various methods for both formative and summative assessment: written exams, oral exams, such as presentations, individual and group project work, as well as homework assignments assessed by teaching assistants and by the students themselves. Every course contains at least one summative test. In addition, the possibility of implementing the Buddy Check tool in the MSc is being investigated. Internships are evaluated by the daily supervisor of the company, institution or external organisation involved, while the final decision to award a pass/fail mark rests with the scientific staff member. Internships can serve as a starting point for the thesis project, finally resulting in a scientific report. While Dutch students mostly choose to do their internships abroad, international students typically remain in the Netherlands.

The panel considers the assessment system of **both programmes** to be well-designed and coherent, with assessment methods that are appropriate for the courses' learning goals and sufficient attention to skills. It appreciates the assessment plan linked with the ILOs and the diversity in assessment methods used. The panel observes that appropriate procedures are in place to ensure and enhance the quality of assessment. For example, examiners apply the four-eyes principle when constructing tests. Furthermore, the panel notes that new lecturers are not designated as examiners for major courses in their first three years of service and are paired with senior colleagues who act as mentors. An educational advisor with assessment expertise monitors the quality of assessment by providing regular feedback on the assessment for all courses, focusing on issues such as reliability, validity, construction and the safeguarding of learning goals. Additionally, a bi-weekly walk-in session and a two-monthly workshop for teachers were initiated, to improve communication with teachers about assessment quality. The panel acknowledges the enhancements that have been implemented and values the assistance provided by ESA in this regard.

Final assessment

The final product of the **BSc Wb programme** is the Bachelor Final Project (BEP) of 14 EC, which covers all intended learning outcomes at an individual level. The BEP is organized in groups of 4 students and consists of both an individual and group assessment. The BEP has two mid-term colloquia in which the teams present their progress to their peers and get feedback from departmental staff, which the panel appreciates. The panel was informed that each student is graded by their supervisor based on individual performance. Furthermore, a graduation committee consisting of three staff members assesses each student individually based on performance during an exam session. There is also an assessment for presentation of the teamwork by a departmental colloquium committee.

As part of the accreditation process, the panel reviewed a selection of 5 BEP projects (20 students) from the BSc Wb programme, including the corresponding assessment forms. The rubric for the BEP specifies the assessment criteria based on the ILOs and serves as a basis for grading. The panel agrees with the grades awarded to the projects, which are generally of expected quality. The panel learnt that in general, the Board of Examiners is pleased with the BEP procedure. However, the Board of Examiners observes – as also mentioned in their annual report – that the individual assessment of the students could be improved, and the current rubric is not fully suitable for this purpose. For this reason, it recommended modifying the existing rubric or adding a rubric, in order to put more emphasis on individual assessment. The panel shares the Board of Examiners' view that the individual component of the BEP could be better developed. Yet, according to the panel, there is a clear procedure in place: 55% of the grade is a group grade, and 45% is based on individual performance, with 25% for the process and 20% for the defence. Elements have also been built in as input for the individual assessment, namely a logbook for project work per student – which the panel is positive about – and the final presentation. This ensures that all students individually meet the minimum requirements for graduation and cannot freeride on the final project. In practice, though, this

procedure seems to leave a lot of freedom for individual assessors, frequently leading to group members all receiving the same grades.

Therefore, the panel recommends that the programme strengthen the BEP process, and carefully document and validate the individual assessments by providing examiners with more tools to differentiate between individual students. For example, by creating a separate assessment form for individual assessment with room for feedback, and/or guidelines and rubrics for examiners to differentiate in individual grades of students in the oral examination. The panel also suggests providing (oral) feedback on the final product, for example during a project debriefing. Furthermore, it became evident from the interviews that project feedback by peers during the BEP could be improved; students expressed a desire for more feedback to enhance their learning. According to the panel, peer assessment could be used for individual grading, encouraging students to learn from each other. This does, however, require adequate training and coaching of students in feedback literacy.

In the **MSc ME programme**, each track is completed with a thesis project of 35 EC. The programme informed the panel that it puts a strong emphasis on the quality and level of thesis projects, which the panel appreciates. The panel values that students can use the preceding curriculum components (the research assignment/internship and literature survey) as starting points for the thesis project, basing the thesis on the literature review or drawing inspiration from challenges encountered in the industry. Students have to write a structured scientific report, present their findings at a public colloquium, and defend their work before a graduation committee. Industrial partners can take part in the committee as guests. The thesis work is assessed according to uniform assessment criteria, set out in the Master Thesis Grading Rubric. This includes criteria about time management and planning (transferable skills). External supervisors have an advisory role in the assessment of students, whereas the formal assessment is conducted by the TUD examiners. The panel reviewed a selection of 15 MSc theses, including the corresponding assessment forms. The rubric specifies the assessment criteria based on the ILOs, is well-defined and consistently used; it is also available for students. The panel agrees with the grades awarded to the theses and found the grades to be well substantiated. The theses are generally of expected quality, present a good mix of theory and experiments, and deal with highly relevant topics.

As for the duration of the graduation project, the panel learnt that faculty management is looking to streamline processes and ensure consistency across programmes and supervisors; stricter compliance with the thesis rubric and guidelines is considered crucial. The panel fully supports the focus on this matter. It finds it essential to pursue further action to avoid a ‘grey area’. Currently, extending the graduation project may occasionally result in a higher grade, while in other situations it could lead to a grade reduction, irrespective of the particular circumstances related to the delay. According to the panel, a more defined timeline with specific start and end dates and further intensified guidance would be beneficial for students, as it would help eliminate prolongation, especially when this is caused by enthusiastic supervisors that focus on project results and lose sight of the envisioned timeline. Furthermore, the panel is of the opinion that there is room for improvement regarding the calibration of thesis assessments. While some calibration appears to exist in specific instances, such as for cum laude distinctions, more frequent discussions about assessment are recommendable, to ensure alignment and coherence between tracks and consistency in grading.

Board of Examiners
The ME programmes fall under the responsibility of the ME Board of Examiners, one of the two faculty-wide Boards of Examiners. Based on the documentation and the interviews during the site visit, the panel concludes that the Board of Examiners adequately safeguards the quality of assessment in the programme.

It proactively controls the quality of assessment in various ways, such as appointing examiners (holding a UTQ or in the process of obtaining a UTQ), and assessing the quality of examinations through a random sampling of exams and final projects. It inspects the thesis works and accompanying assessment forms twice a year and assesses whether the graduation committees made fair judgements leading to the final grades, as well as the distribution of grades per track. The panel commends the Board of Examiners for their thorough evaluation of the BEP procedure and their valuable advice. They encourage the Board of Examiners to ensure that these matters are appropriately addressed by the BSc Wb programme. Furthermore, the Board of Examiners has set strict rules for the compilation of graduation committees and for graduating with distinction. The rules for graduation committees have been revised and now include a mandatory member with experience in assessment. Moreover, one of the staff members needs to be independent, not having been involved in the graduation project. One extra scientific staff member, employed in another department, is added to the committee in cases where the candidate is eligible for the designation cum laude.

The Board of Examiners also deals with reports of suspicions of fraud and complaints. Complaints regarding courses (approximately 30 per year) are forwarded to the responsible lecturers or addressed through mediation. There are virtually no complaints regarding thesis grades. The Board of Examiners believes this is likely connected to the 'green light meetings,' during which students are given a go/no go decision for their thesis; in case of a ‘no go’, students can either make repairs or start over. The Board of Examiners has regular meetings with the Dean, the director of education, the head of the ESA department, the educational advisor on assessment and the quality assurance department. It also meets with other TUD Boards of Examiners to discuss common concerns and to improve assessment. The panel is pleased to see that the Board of Examiners clearly contributes to the quality of assessment in the programme.

Considerations

The panel concludes that the assessment system of both programmes is transparent and well designed. Adequate procedures, such as the four-eyes principle, are in place to ensure and enhance the quality of assessment. The assessment methods used are diverse and appropriate, and include assessment of skills. Amongst others, the panel appreciates the attention for constructive alignment, the standard rubrics for the literature research and MSc thesis, and the support offered by ESA.

The panel is positive about the digitalization of assessment in the **BSc Wb programme**, resulting in less administrative workload, and the exploration of adaptive testing, which allows for more efficient and personalized assessments. The Bachelor Final Project (BEP) covers all ILOs of the programme at an individual level. The panel considers the BEP assessment procedure to be well thought out, and the grades awarded to be sufficiently substantiated. Procedures, such as a logbook for project work per student and assessment of individual performance, ensure that all students individually meet the requirements for the BEP. Even so, the individual component in the BEP could be better developed. The panel recommends strengthening the BEP process, and documenting and validating individual assessments by equipping examiners with additional tools to differentiate between students. The Board of Examiners is very aware of this issue; following their recommendations, the panel encourages the programme to take further action in this regard. It also recommends offering (oral) feedback on the final BEP product. Furthermore, the panel advises to establish a learning line peer assessment; incorporating peer assessment for individual grading could promote collaborative learning among students. This approach necessitates proper training and coaching for students in feedback literacy.

The graduation project for each track covers all ILOs of the **MSc ME programme** at an individual level. The panel appreciates the set-up of the thesis project and the way it is evaluated according to uniform assessment criteria, set out in a clear rubric. According to the panel, the grades awarded are sufficiently

substantiated. As for the duration of the graduation project, the panel encourages the programme to streamline processes and ensure consistency across tracks and supervisors. Furthermore, the duration allocated for the final thesis should not exceed the time associated with the assigned EC. According to the panel, establishing a clear timeline and providing more intensive guidance would help students successfully finish their thesis within 7 months. Furthermore, the panel encourages the programme to calibrate more often regarding thesis assessment, to ensure alignment and coherence between tracks.

According to the panel, the Board of Examiners proactively contributes to the quality of assessment in the programme. It has a clear task and safeguards the quality of assessment in the programme in various ways, including the continuous assessment of the quality of examinations.

Conclusion

The panel concludes that the bachelor's programme Mechanical Engineering meets standard 3.
The panel concludes that the master's programme Mechanical Engineering meets standard 3.

Standard 4. Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

Theses

The Bachelor End Project (BEP) is regarded as the **BSc Wb programme's** final project in which students demonstrate that they achieved the BSc programme's ILOs at an individual level. In the **MSc ME programme's** graduation project (thesis project), students demonstrate that they achieved the MSc programme's ILOs at an individual level. In preparation for the site visit, the panel examined the final products of 20 BSc students (5 projects) and 15 MSc theses. In the selection, a proper distribution across grades was ensured. In the opinion of the panel, the level of the examined BEP's and theses is appropriate for an academic bachelor's and master's programme, respectively. The end projects and theses demonstrate the achievement of the ILOs. In general, they are of expected quality. Regularly, an MSc graduation study results in a scientific publication.

Alumni

The panel is pleased to observe the strong confidence among BSc students about their future careers, as well as the significant number of students successfully pursuing a master's degree. Only a small percentage of the **BSc Wb programme's** graduates (less than 5%) leaves university after completing their BSc degree; they find employment in a wide range of industries, including the process and energy industry, developers of medical and robotic devices, and transport & logistics. The majority of graduates continue with an MSc study, most of them in related programmes within the ME faculty, or other TUD MSc programmes such as Aerospace Engineering and Sustainable Energy Technology. The panel was informed that about half of the BSc graduates choose to continue with a master's programme in the same department where they completed their BEP. BSc Wb students feel that the knowledge they acquired is highly relevant to their future careers. They particularly value the hands-on experience, practical knowledge and insights gained during projects, offering a deeper understanding of manufacturing processes and engineering principles.

The panel appreciates how in the **MSc ME programme** students are stimulated through numerous activities to become more acquainted with the future labour market. These include guest lectures, internships,

research assignments, (interdisciplinary) projects, the thesis project, and career-related events organized by the study associations for each track. The panel values the career events, which include an annual career fair and excursions to companies. Career orientation is further supported by the Career Centre TUD. MSc ME students view their career prospects following the programme positively. This is partially attributed to the practice-oriented cases that are covered in some courses and the strong connections of lecturers with industry. A recent survey (2023) shows that the respondents consider the programme a good start for their careers. Almost all graduates easily find a job within two months after graduation. They find employment in, for example, the manufacturing industry, high-tech engineering companies, consultancy firms, and transhipment and logistics companies in the Netherlands and abroad. About 10% of the alumni continued as PhD students at TUD or other universities after graduation, pursuing a more research oriented career. The panel is positive about the fact that most alumni found professional positions that match the programmes' content and level. It also values the alumni association, managed by volunteers, which provides a valuable professional and social network for both graduates and students in Mechanical Engineering.

The panel observes that alumni of **both programmes** are generally positive about the programme and often secure relevant positions after graduation. As they indicated during the site visit and in the most recent alumni survey, alumni developed valuable knowledge and skills during the programmes and feel well prepared for the labour market. During the site visit, the professional field representatives informed the panel that TUD alumni possess good modelling and problem solving skills as well as a solid knowledge basis. They are highly motivated and show leadership qualities. They do require coaching in time management and collaboration skills, such as engaging with stakeholders. However, according to the panel this is a broader trend that extends beyond just TUD alumni.

Considerations

Based on the examination of a selection of end projects and theses from the programmes, the panel concludes that the level of the Bachelor End Projects and theses is appropriate for an academic bachelor's and master's programme, respectively. They demonstrate the achievement of the ILOs. The documentation and interviews show that alumni are generally content with the programmes and are well prepared to perform successfully in the professional field in the Netherlands and abroad.

Conclusion

The panel concludes that the bachelor's programme Mechanical Engineering meets standard 4.
The panel concludes that the master's programme Mechanical Engineering meets standard 4.

General conclusion

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

Recommendations

Bachelor's programme Mechanical Engineering

1. Raise awareness of social safety among students and take proactive measures to ensure a socially safe environment, and improve the visibility of the Ombudsperson for students.
2. Establish a learning line peer assessment that extends to the Bachelor End Project (BEP), fostering collaborative learning among students. This involves providing adequate training and coaching to help students develop their feedback literacy skills.
3. Keep an eye on the effects of a reduced role of teaching assistants on teaching staff workload.

4. Strengthen the BEP process, and carefully document and validate the individual assessments by providing examiners with more tools to differentiate between individual students.

Master's programme Mechanical Engineering

5. Enhance the integration of a broader perspective and of soft skills, including attention to ethics, into the compulsory (technical) courses.
6. Calibrate more often regarding thesis assessment, to ensure alignment and coherence between tracks.
7. Establish a more defined timeline for the thesis project and enhance the support provided to students to avoid delays.

Both programmes

8. Increase students' awareness of the AI policy by incorporating AI more extensively into the teaching process.
9. Proactively address the workspace challenges, to ensure there are enough dedicated areas for group projects and graduation work.
10. Enhance the monitoring of workload across courses and academic quarters and reassess the allocation of ECs for certain courses with respect to their workload.
11. Conduct a more comprehensive follow-up on the duration of studies, especially regarding MSc theses.

Appendix 1. Intended learning outcomes

Bachelor's programme Mechanical Engineering

A graduate in Mechanical Engineering is able to...

1. Skilled in the scientific discipline of mechanical engineering
   - 1A ... solve problems of medium difficulty in the fundamental engineering sciences that form the basis of mechanical engineering: mechanics, thermodynamics, transport phenomena, materials science, control engineering and mechatronics and mathematics, especially analysis and algebra.
   - 1B ... solve elementary problems in related fields: electricity and magnetism, electronics, computer science and chemistry.
   - 1C ... solve problems of medium difficulty in the main application areas of mechanical engineering: mechanical systems, production technology, process and power technology and robotics.
2. Proficient in doing research
   - 2A ... apply knowledge and skills in the field of mechanical engineering to investigate mechanical systems.
   - 2B ... apply common methods and tools to model, simulate and investigate mechanical systems.
   - 2C ... document used research methods and results in a scientific report or article.
3. Proficient in design
   - 3A ... apply knowledge and skills in the field of mechanical engineering to design mechanical systems.
   - 3B ... develop complex mechanical systems using a systematic mechanical design process tailored to the specific design problem and context.
   - 3C ... develop innovative contributions to the field of mechanical engineering using multiple creative techniques including the Abstract & Categorize, Reflect, Reformulate & Extend – strategy (ACRREx).
4. A scientific approach
   - 4A ... define and analyse problems, from academic and basic to industrial and applied.
   - 4B ... develop innovative solutions to problems and evaluate the feasibility and limitations of these solutions.
5. Basic intellectual skills
   - 5A ... systematically gather relevant information to solve problems.
   - 5B ... maintain and expand own knowledge and skills through self-study.
   - 5C ... reflect critically on own knowledge, skills and attitude.
   - 5D ... take a rational position on a scientific or technical discussion in the field of research and/or design.
   - 5E ... plan independently and evaluate and reflect on it in a timely manner.
6. Proficient in collaboration and communication
   - 6A ... work individually and with a high degree of independence.
   - 6B ... work in teams and divide sub-tasks within a team.
   - 6C ... explain and defend research and design results to specialists and colleagues from academia and industry.
   - 6D ... present and report work in Dutch according to the prevailing standards of style, structure and care.
7. Takes temporal and social context into account
   - 7A ... evaluate and assess the technological, ethical and social impact of own work.
   - 7B ... act responsibly with regard to sustainability, economy and social welfare.

Master's programme Mechanical Engineering (general and per track)

A graduate in Mechanical Engineering is able to...

1. Competent in the scientific discipline Mechanical Engineering
   - 1A. ...apply advanced physics and measurement methods in mechanical systems.
   - 1B. ...design, carry out and evaluate experiments.
   - 1C. ...identify, design and control mechanical systems in an interactive and noisy environment.
   - 1D. ...relate scientific knowledge to mechanical systems considering their interaction with the environment.
2. Competent in doing research
   - 2A. ...study a topic by critically selecting relevant scientific literature.
   - 2B. ...write a scientific report about own research.
   - 2C. ...analyse mechanical systems at various levels of abstraction.
   - 2D. ...generate knowledge within the discipline of Mechanical Engineering.
3. Competent in designing
   - 3A. ...systematically design complex mechanical systems.
   - 3B. ...generate innovative contributions to the discipline of Mechanical Engineering.
4. A scientific approach
   - 4A. ...apply paradigms, methods and tools to (re)design a mechanical system.
   - 4B. ...manage own scientific research independently.
   - 4C. ...analyse problems and use modelling, simulation, design and integration towards solutions.
5. Basic intellectual skills
   - 5A. ...analyse and solve technological problems in a systematic way.
   - 5B. ...plan and execute research and design in changing circumstances.
   - 5C. ...integrate knowledge in an R&D project, considering ambiguity, incompleteness and limitations.
   - 5D. ...identify and acquire lacking expertise.
   - 5E. ...critically reflect on own knowledge, skills and attitude.
   - 5F. ...remain professionally competent.
   - 5G. ...take a standpoint with regard to a scientific argument within the research area.
6. Competent in operating and communicating
   - 6A. ...work both independently and in multidisciplinary teams.
   - 6B. ...present and report in good English.
   - 6C. ...explain and defend outcomes from the research area to academia and industry, to specialists and laymen.
7. Considering the temporal and social context
   - 7A. ...evaluate and assess the technological, ethical and societal impact of own work.
   - 7B. ...act responsibly with regard to sustainability, economy and social welfare.

Track BioMechanical Design (BMD)

1. Competent in the scientific discipline Mechanical Engineering
   - 1A ... apply advanced physics and measurement methods in mechanical and biological systems.
   - 1B ... optimize the interaction between biological and mechanical systems and to think of innovative technical solutions.
   - 1C ... analyse the motions of linked rigid body systems in two and three dimensions including systems with various kinematic constraints.

- 1D ... use multibody dynamics models, appreciate the limitations and draw sensible conclusions about the modelled system.
- 1E ... reproduce important concepts of human perception, cognition and action.

2. Competent in doing research
   - 2A ... explain the interaction between humans and machines, ranging from manual to supervisory control.
   - 2B ... apply existing techniques to measure and model human behaviour when interacting with machines.
   - 2C ... explain the advantages and disadvantages of automation and the effects of automation on humans.
   - 2D ... explain how human skills develop and how feedback influences skill acquisition.
3. Competent in designing
   - 3A ... design autonomous operating systems, capable of human-like actions and interaction.
   - 3B ... apply unconventional biological approaches in engineered systems.
4. A scientific approach
   - 4A ... carry out human-subject research in an ethical manner.
   - 4B ... apply methods for conducting research or design projects, in particular related to human behaviour, interaction between humans and their technical environment and intelligent machines.
   - 4C ... solve multidisciplinary problems between engineering and human factors science.
5. Basic intellectual skills
   - ... no additional qualifications
6. Competent in operating and communicating
   - 6A ... no additional qualifications
7. Considering the temporal and social context
   - 7A ... explain the historic development of the discipline, its technological and scientific boundaries and the necessity of life-long learning to maintain the desired level.

Track Energy, Flow & Process Technology (EFPT)

1. Competent in the scientific discipline Mechanical Engineering
   - 1A ... apply knowledge of fluid dynamics, applied thermodynamics, heat- and mass transfer to the disciplines covering the domain of energy technology, fluid flow and process technology.
2. Competent in doing research
   - 2A ... apply knowledge of fluid dynamics, applied thermodynamics, heat- and mass transfer at an advanced level in theoretical and/or experimental research to solve problems and/or to generate new knowledge.
3. Competent in designing
   - 3A ... analyse, design and evaluate systems in the area of energy technology, fluid flow and process technology in particular for details of equipment for heat- and mass transfer.
   - 3B ... analyse technical designs related to equipment.
4. A scientific approach
   - ... no additional qualifications
5. Basic intellectual skills
   - ... no additional qualifications
6. Competent in operating and communicating
   - 6A ... no additional qualifications
7. Considering the temporal and social context
   - 7A ... describe and implement sustainable development based on thermodynamic fundamentals.

Track High-Tech Engineering (HTE)

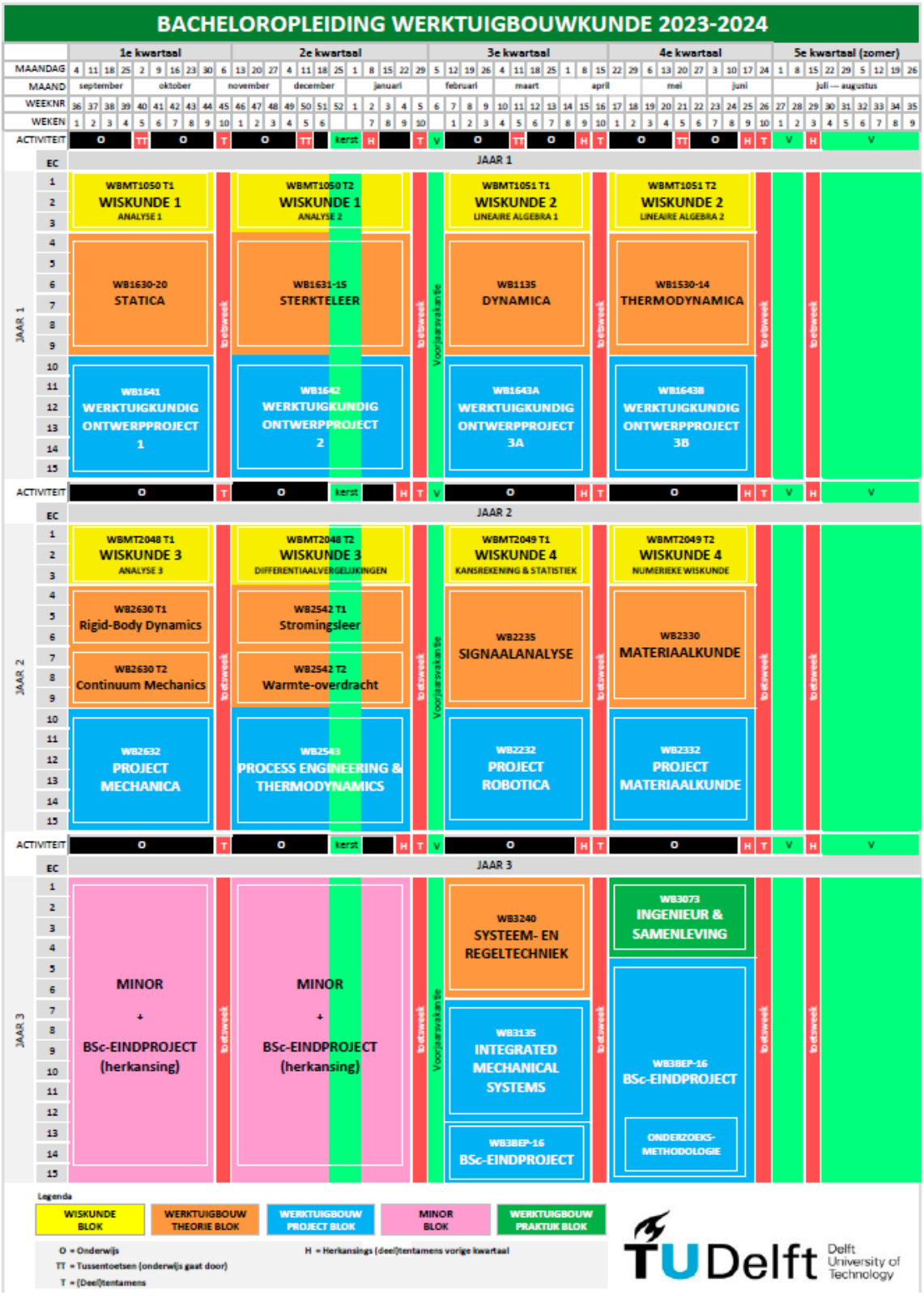
1. Competent in the scientific discipline Mechanical Engineering
    - 1A ... apply standard linear and non-linear methods, in theory and experiment.
    - 1B ... develop computational techniques for linear and non-linear analysis.
    - 1C ... evaluate concepts of mechatronic systems, including tribology, bearing concepts and vibration isolation.
    - 1D ... synthesize special and temporal discretization techniques, multi domain integration and interaction, and linear and non-linear solution techniques.
    - 1E ... describe and analyse microsystems and their working principles.
    - 1F ... apply numerical modelling techniques for linear and non-linear problems, simulation of multi-physics problems and numerical optimisation techniques.
2. Competent in doing research
    - ... no additional qualifications
3. Competent in designing
    - 3A ... describe microfabrication techniques and use this in design of microsystems.
    - 3B ... apply scaling laws and characterization techniques.
    - 3C ... design high precision mechatronic systems and compliant mechanisms.
4. A scientific approach
    - ... no additional qualifications
5. Basic intellectual skills
    - ... no additional qualifications
6. Competent in operating and communicating
    - ... no additional qualifications
7. Considering the temporal and social context
    - ... no additional qualifications

Track Multi-Machine Engineering (MME)

1. Competent in the scientific discipline Mechanical Engineering
    - 1A ... analyse and explain the characteristics and mechanical behaviour of material during transport and storage
    - 1B ... analyse and model different types of transport equipment and transport facilities
    - 1C ... analyse and model the logistics of complex transport systems and networks
2. Competent in doing research
    - ... no additional qualifications
3. Competent in designing
    - 3A ... model the dynamics of the interaction between equipment and materials
    - 3B ... design, control and automate transport equipment and facilities
    - 3C ... develop, monitor and control components for transport and logistic systems and networks
4. A scientific approach
    - ... no additional qualifications
5. Basic intellectual skills
    - ... no additional qualifications
6. Competent in operating and communicating
    - ... no additional qualifications
7. Considering the temporal and social context
    - 7A ... explain the importance of transport systems and logistics in society

Appendix 2. Programme curriculum

Bachelor's programme Mechanical Engineering



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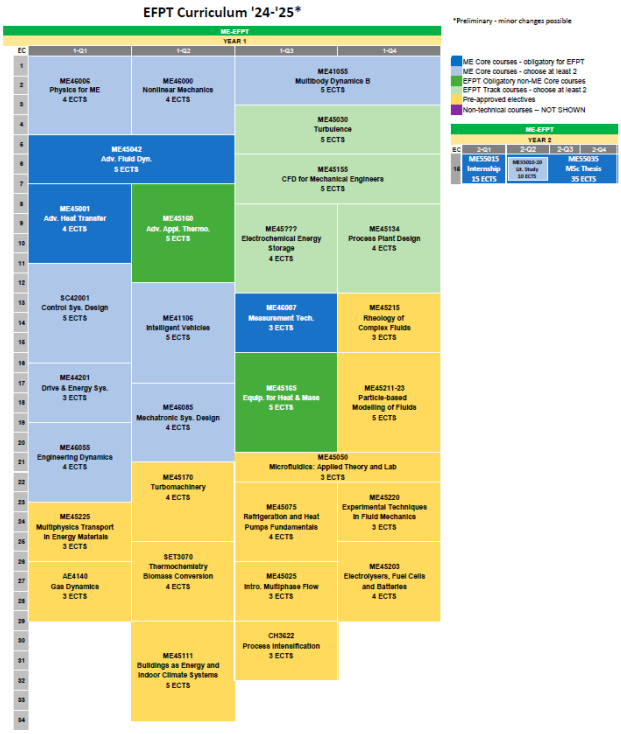
Master's programme Mechanical Engineering

Track BioMechanical Design

First Year (60 EC)		
Obligatory Courses 29-32 EC	**ME Core Courses** Select at least 2	**Design Project Courses** Select at least 2
Control System Design	Advanced Fluid Dynamics	Bio Inspired Design
Human Robot Interaction	Advanced Heat Transfer	Bio Mechatronics
Measurement Technology	Drive & Energy Systems	Compliant Mechanisms
Multibody Dynamics B	Engineering Dynamics	Medical Device Prototyping
Musculoskeletal Modeling and Simulation	Intelligent Vehicles	Precision Mechanism Design
Neuromechanics & Motor Control	Mechatronic System Design	
Social / Ethics Course	Nonlinear Mechanics	
	Physics for Mechanical Engineers	
Electives Complete your individual study programme by freely choosing from these and other courses		
Robotics & Control	*Biomedical Engineering*	*Engineering Design & Research*
Control in Human-Robot Interaction	Anatomy and Physiology	3D Printing
Control Systems Lab	Applied Experimental Methods: Medical Instruments	Freehand Sketching of Products and Mechanisms
Planning & Decision Making	Special Topics in Sports Engineering	Introduction to Engineering Research
Robot Software Practicals	Tissue Biomechanics	System Identification and Parameter Estimation

Second Year (60 EC)	
Second Year Project Choose one option (15 EC)	**Graduation Project** 45 EC
Internship	Literature Study 10 EC
Joint Interdisciplinary Project	
Electives	MSc Thesis 35 EC

Track Energy, Flow & Process Technology



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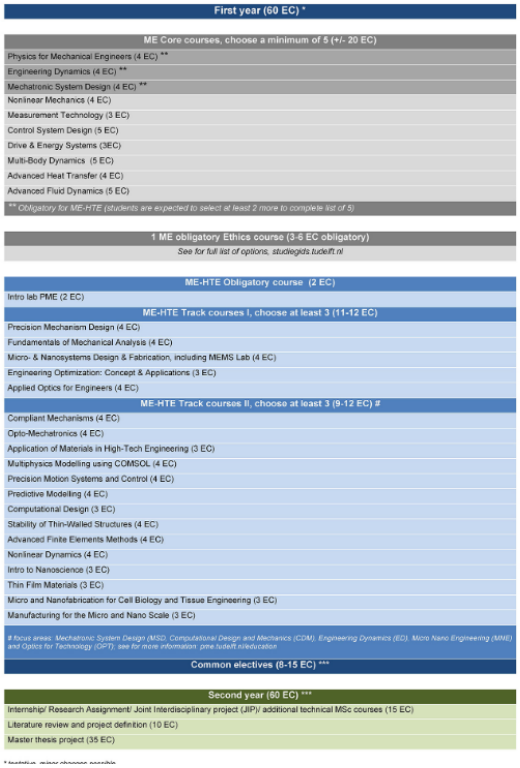
Track High-Tech Engineering



First year (60 EC) *
ME Core courses, choose a minimum of 5 (+/- 20 EC)
Physics for Mechanical Engineers (4 EC) **
Engineering Dynamics (4 EC) **
Mechatronic System Design (4 EC) **
Nonlinear Mechanics (4 EC)
Measurement Technology (3 EC)
Control System Design (5 EC)
Drive & Energy Systems (3EC)
Multi-Body Dynamics (5 EC)
Advanced Heat Transfer (4 EC)
Advanced Fluid Dynamics (5 EC)
*** Obligatory for ME-HTE (students are expected to select at least 2 more to complete list of 5)*
1 ME obligatory Ethics course (3-6 EC obligatory)
See for full list of options, studiegids.tudelft.nl
ME-HTE Obligatory course (2 EC)
Intro lab PME (2 EC)
ME-HTE Track courses I, choose at least 3 (11-12 EC)
Precision Mechanism Design (4 EC)
Fundamentals of Mechanical Analysis (4 EC)
Micro- & Nanosystems Design & Fabrication, including MEMS Lab (4 EC)
Engineering Optimization: Concept & Applications (3 EC)
Applied Optics for Engineers (4 EC)
ME-HTE Track courses II, choose at least 3 (9-12 EC) #
Compliant Mechanisms (4 EC)
Opto-Mechatronics (4 EC)
Application of Materials in High-Tech Engineering (3 EC)
Multiphysics Modelling using COMSOL (4 EC)
Precision Motion Systems and Control (4 EC)
Predictive Modelling (4 EC)
Computational Design (3 EC)
Stability of Thin-Walled Structures (4 EC)
Advanced Finite Elements Methods (4 EC)
Nonlinear Dynamics (4 EC)
Intro to Nanoscience (3 EC)
Thin Film Materials (3 EC)
Micro and Nanofabrication for Cell Biology and Tissue Engineering (3 EC)
Manufacturing for the Micro and Nano Scale (3 EC)
 # focus areas: Mechatronic System Design (MSD, Computational Design and Mechanics (CDM), Engineering Dynamics (ED), Micro Nano Engineering (MNE) and Optics for Technology (OPT); see for more information: pme.tudelft.nl/education
Common electives (8-15 EC) * **
Second year (60 EC) * **
Internship/ Research Assignment/ Joint Interdisciplinary project (JIP)/ additional technical MSc courses (15 EC)
Literature review and project definition (10 EC)
Master thesis project (35 EC)

Track Multi-Machine Engineering

Obligatory courses

	theme	code	ECTS	1A	1B	2A	2B	
Drive & Energy Systems	DES	**me44210**	3	3				
Nonlinear Mechanics	NLM	**me46000**	4		4			
Measurement Technology	MT	**me46007**	3			3		
Control System Design	CSD	**sc42001**	5	5				
								15
Dynamics and Interaction of Material and Equipment	1	**me44101**	4	4				
Operations & Maintenance	2	**me44200**	3			3		
Multi-Machine Coordination for Logistics	3	**me44300**	3				3	
								10
Structural Design with FEM	1	**me44106**	4		4			
Integration Project Multi-Machine Systems	1, 2	**me44110**	5			2	3	
Quantitative Methods for Logistics	2, 3	**me44206**	5	2	3			
System Analysis and Simulation	2, 3	**me44305**	5			2	3	
								19
		obligatory courses	**44**	**14**	**11**	**10**	**9**	

ME common course electives (select one)

Multibody Dynamics B	MDB	**me41055**	2	2	2		
Intelligent Vehicles 3ME	IV	**me41106**	5		5		
Advanced Heat Transfer	AHT	**me45001**	4	4			
Advanced Fluid Dynamics	AFD	**me45042**	5	2	3		
Physics for Mechanical Engineers	PhME	**me46006**	4	4			
Engineering Dynamics	ED	**me46055**	4	4			
Mechatronic System Design	MSD	**me46085**	4		4		

Track electives

Discrete Element Method (DEM) Simulation	1	**me44115**	4		4		
Reliability and Maintenance of Transport Equipment	2	**me44125**	3			3	
Advanced Operations and Production Management	3	**me44311**	5			2	3
Machine Learning for Transport and Multi-Machine Systems	3	**me44312**	3			3	
Mechatronics in MT	1, 2, 3	**mt44000**	5			5	

Free electives

select from studyguide							
		elective courses	**16**				
		1st year MSc	**60**				

lectures + final exam
(group) assignment + final report

Appendix 3. Programme of the site visit

Day 1: Tuesday 5 November

08.45 – 09.00	Welcome
09.00 – 09.30	Preliminary internal panel meeting
09.30 – 10.00	Session faculty management
10.00 – 10.45	Session programme directors
10.45 – 11.15	Break
11.15 – 12.00	Session bachelor's students Maritime Technology
12.00 – 12.45	Session master's students Marine Technology
12.45 – 13.45	Lunch break
13.45 – 14.30	Session teaching staff BSc + MSc MT
14.30 – 14.45	Break
14.45 – 15.30	Session Board of Examiners
15.30 – 15.45	Break
15.45 – 16.15	Theme session BSc Maritime Technology
16.15 – 16.45	Theme session MSc Marine Technology
16.45 – 17.15	Session programme directors BSc + MSc MT
17.15 – 17.45	Internal panel review meeting (BSc + MSc MT)

Day 2: Wednesday 6 November

08.45 – 09.00	Preliminary internal panel meeting
09.00 – 09.45	Session bachelor's students Mechanical Engineering
09.45 – 10.30	Session master's students Mechanical Engineering
10.30 – 11.00	Break
11.00 – 12.00	Session teaching staff BSc + MSc Mechanical Engineering
12.00 – 13.00	Lunch break
13.00 – 14.00	Theme session BSc Mechanical Engineering
14.00 – 14.30	Theme session MSc Mechanical Engineering
14.30 – 15.00	Break
15.00 – 15.45	Faculty tour
15.45 – 16.15	Session programme directors BSc + MSc ME
16.15 – 16.45	Internal panel review meeting (BSc + MSc ME)
16.45 – 17.30	Session alumni / professional field master's programmes (ME, MSE, MT, ODE)
17.30 – 18.00	Internal panel review meeting (BSc + MSc ME)

Day 3: Thursday 7 November

08.45 – 09.00	Preliminary internal panel meeting
09.00 – 09.30	Session master's students Materials Science and Engineering
09.30 – 10.00	Session teaching staff MSc Materials Science and Engineering
10.00 – 10.15	Break
10.15 – 10.45	Theme session MSc Materials Science and Engineering
10.45 – 11.00	Session programme director MSc MSE
11.00 – 11.30	Internal panel review meeting (MSc MSE)
11.30 – 12.00	Session master's students Offshore and Dredging Engineering
12.00 – 12.30	Session teaching staff MSc Offshore and Dredging Engineering
12.30 – 13.15	Lunch break
13.15 – 13.45	Theme session MSc Offshore and Dredging Engineering
13.45 – 14.00	Session programme director MSc ODE
14.00 – 14.30	Internal panel review meeting (MSc ODE)
14.30 – 15.00	Final session faculty management
15.00 – 16.30	Concluding panel session
16.30 – 16.45	Oral feedback session
16.45 – 18.00	Drinks

Appendix 4. Materials

Prior to the site visit, the panel studied 20 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:

- Self-evaluation report BSc Mechanical Engineering, including the following appendices:
    - Overview NVAO and midterm recommendations and measures taken
    - Comparison with other Mechanical Engineering bachelor programmes
    - Final Qualifications BSc WB
    - TU Delft Note on "Duty of Care"
    - Relation between final qualifications and WB curriculum
    - Curriculum on Domain Specific level
    - Organisation of the first year
    - Overview of WB Courses and Assessments 2023-2024
    - Results National Student Survey 2023
    - Overview of WB teaching staff
    - Bachelor End Project Grading Rubric

- Self-evaluation report MSc Mechanical Engineering, including the following appendices:
    - Overview NVAO and midterm recommendations and measures taken
    - Final Qualifications MSc ME per track
    - TU Delft Note on "Duty of Care"
    - Relation between Final Qualifications and MSc ME Curriculum per Track
    - Results National Student Survey 2023
    - Overview of MSc ME teaching staff
    - Literature review and Master Thesis Grading Rubric

Also included were:

- TU Delft Vision on Education
- Faculty ME Vision on Education
- Annual Reports BSc and MSc ME 2022-2023
- Assessment framework TUD
- Assessment in ME (including assessment programme)
- Teaching and Examination Regulations BSc Wb and MSc ME 2023-2024
- Rules and Guidelines Board of Examiners
- Annual reports Board of Examiners
- Comparison of Skills within eight different European BSc-ME programmes
- BEP Wb Guide
- Overview of Wb graduation works 2021-2022 & 2022-2023
- Selected BSc graduation works and rubrics
- MSc Graduation Guide
- Overview of master theses
- Selected MSc thesis works and rubrics