Assessment plan for the curriculum of the Master's degree programme in Mechanical Engineering, 2024-2025

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Date approval Faculty Board:

1. Vision on assessment

1. We assess our students by different means such as assignments, reports, programming codes, presentations, tutorial problem sheets, class tests and final exams. This would allow us to assess their knowledge and learning and how they can apply this knowledge to engineering problems. Therefore, an assessment should be of different kinds to assess different skills.
2. The design project in the companies during their internship can be used to assess on how they can apply their theoretical knowledge in practical application. This gives us feedback on how they can critically think to implement their theoretical knowledge gained during the first year.
3. The research project can be used to assess how they can do fundamental research and work in an academic environment.
4. Feedback formally and informally can be used to assess students' learning.
5. The assessment should be aligned with learning outcomes.

2. Assessment guidelines

1. Summative and formative assessment should both be used for high quality teaching/learning.
2. Formative assessment is through class tests, presentations, informal discussion, ...
3. Summative assessment through assignments, written reports, final exam, and they should be in alignment with the learning outcomes.

3. Learning outcomes of the degree programme

	Learning Outcomes
1	On knowledge and understanding, the graduate: 1.1. has knowledge of the underlying concepts of mechanical engineering, including the necessary physics, mathematics and computer science, at a level that permits admission to a higher-level post-graduate programme. 1.2. is familiar with the quantitative character of mechanical engineering and with the relevant research methods. 1.3. has operational knowledge and design skills in the field of mechanical engineering.

	1.4. has a thorough understanding of: a. advanced instrumentation (for Advanced Instrumentation Track). b. smart processes, engineering materials and products (for Smart Factories Track). c. process design for energy systems (for Smart and Green Energy Systems Track). 1.5. has knowledge in the field of business and management.
2	On the synthesis and application of knowledge and understanding, the graduate is able to: 2.1. carry out research in order to understand phenomena that are usable in developing mechanical engineering applications. 2.2. analyse a (new) complex applied problem, and develop a structured and well-planned approach to search for a solution. 2.3. apply his/her mechanical engineering knowledge and skills in his/her own and related subject areas. 2.4. seek new applications for mechanical engineering concepts. 2.5. use advanced instrumentation and/or advanced programming tools. 2.6. apply mechanical engineering concepts in an industrial environment or in an international mechanical engineering research environment. 2.7. collaborate in a (multi-disciplinary) international research and design team.
3	On reasoning and judgement, the graduate: 3.1. is able to obtain relevant information using modern information channels, and interprets this information critically for specific use in mechanical engineering research. 3.2. judges his/her and others' actions within a scientific context, taking societal and ethical aspects into account. 3.3. is able to draw conclusions on the basis of limited or incomplete information, and realizes and formulates the limitations of such conclusions.
4	On communication skills, the graduate is able to: 4.1. communicate clearly, verbally and in writing, on his/her subject and relevant applications, at different levels understandable to experts and non-experts using relevant communication tools.
5	On learning skills, the graduate is able to: 5.1. address issues inside as well as outside his/her main subject area, therefore and thereby gaining new knowledge and skills. 5.2. familiarize him/herself with recent advances in science and engineering and use them in mechanical engineering applications.

4. Overview of assessment methods, test moments for course units, and examiners

This table shows all the course units for each year of the programme and assessment methods.

As the test moments of courses are not included in the Course Unit Assessment Overview and cannot reliably be taken from last year's schedule, the programme is unable to provide detailed information in the test moment(s) column. To ensure that the assessment moments of the compulsory courses do not all fall in the same period the programme will ask all course coordinators to fill in a spreadsheet in which they indicate in which weeks their assessment falls. This way the course coordinators can see when the assessment moments of the other courses in the programme are. In case there are several deadlines in the same week, the programme can contact the course coordinators to see whether some activities can be shifted.

The ME programme also includes electives organised by other degree programmes that are not mentioned in the table below. For the details of those courses, please refer to the assessment plans of the programmes organising the course.

Year	**Period**	**Course code**	**Course**	**EC**	**Assessment methods**	**Does (part of the) assessment have a formative function?**	**Test moment(s)** (e.g. mid-term, continuous assessment, exam week, etc)	**First examiner**	**Second examiner**
Core ME courses									
1	1a	WMME027-05	Introduction to Data Science	5	WE, P, AST	Yes		dr. E. Wilhelm	prof. dr. ir. B. Jayawardhana
1	1b	WMME028-05	Computational Solid Mechanics	5	WE, OR, AST	No		dr. F. Maresca	prof. dr. A. Vakis
1	2b	WMME012-05	Experimental Design	5	R, AST	No		dr. W. Krijnen	dr. L. Cheng
1	var	various	Course in Business, Management and Society	5	var			Various	Various
2	var	WMME902-40	Master Research Project	40	P, PR, R	Yes		See appendix 1	Various
2	var	WMME901-20	Master Design Project	20	R, PR, AST	Yes		See appendix 1	Various

Year	Period	Course code	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
Business, Management, and Society courses									
1	1a	WMIE006-05	Technology Based Entrepreneurship	5	WE, AST	No		dr. A.J. Frederiks	dr. C. Gambirage
1	1b	WMEE020-05	Sustainable Society	5	WE, AST, P	No		dr. P.J. Upham	dr. P. Pradhan
1	1b	WMBE018-05	Technology and Ethics of Research	5	WE, P, AST	No		dr. G. Andrejc	dr. C. Jedan
1	2a	WMEE008-05	Global Change	5	WE, AST, R			prof. dr. H.A.J. Meijer	prof. dr. H. Chen
1	2b	WMIE027-05	Sustainable Industrial Practice	5	OR, R, P, AST	Yes		dr. ir. G.H. Jonker	dr. M. Taheri
Compulsory courses Advanced Instrumentation									
1	1a	WMAS002-05	Basic Detection Techniques	5	WE, P	No		dr. ir. G. de Lange	prof. T. Oosterloo
1	1b	WMME006-05	Advanced Instrumentation and Extreme Environments	5	WE	No		prof. dr. N. Kalantar-Nayestanaki	ir. P. P. Kooijman
1	2a	WMIE015-05	Analysis and Control of Smart Systems	5	WE	Yes		prof. dr. C. de Persis	prof. N. Monshizadeh Naini
Compulsory course Smart Factories									
1	1a	WMIE005-05	Robotics for IEM	5	WE, R	No		dr. B. Haghighat	prof. dr. ir. B. Jayawardhana
1	1b	WMME007-05	Advanced Processing for Complex Materials	5	WE, R	No		dr. S. Soljoo	prof. dr. J. Post
1	2a	WMIE015-05	Analysis and Control of Smart Systems	5	WE	Yes		prof. dr. C. de Persis	prof. N. Monshizadeh Naini

Year	Period	Course code	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
Compulsory courses Smart and Green Energy Systems									
1	1a	WMME029-05	Electrochemical Systems and Engineering	5	WE, MC, AST	Yes		dr. V. Kyriakou	prof. P. P. Pescarmona
1	2a	WMME018-05	Thermodynamics of Energy Conversion	5	WE	No		prof. dr. A. Purushothaman Vellayani	ir. T. Woudstra
1	2b	WMCE012-05	Advanced Process and Energy Technologies	5	MC, P, R	Yes		prof. J. Yue	dr. V. Kyriakou
Elective courses									
1	1a	WMME009-05	Multibody and Non-Linear Dynamics	5	WE, R, P, PR	Yes		dr. A.O. Krushynska	prof. dr. ir. B. Jayawardhana
1	1a	WMME030-05	Advanced Vibration	5	AST, WE	No		prof. dr. M. Ghandchi Tehrani	dr. L. Cheng
1	1b	WMME020-05	Microfluidics	5	R, PR	Yes		prof. dr. J. Yue	prof. dr. G.J.W Euverink
1	2a	WMME033-05	Capita Selecta in Ocean Energy	5	R	No		prof. A. Vakis	prof. dr. ir. B. Jayawardhana
1	2a	WMME034-05	TinyML: Machine Learning for Embedded Devices	5	WE, AST	Yes		dr. B. Haghighat	prof. dr. ir. B. Jayawardhana
1	2a	WMME021-05	Smart Materials for Engineering	5	WE, R, P	No		dr. M.I. Acuautla Meneses	prof. dr. ir. B.J. Kooi
1	2a	WMME010-05	Applied Optics	5	AST, P, PR, R, WE	Yes		dr. W. Jellema	prof. dr. ir. B. Jayawardhana
1	2a	WMME005-05	Advanced Detection Techniques	5	AST, P	Yes		dr. M. Kavatsyuk	prof. dr. A. Baryshev

Year	Period	Course code	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
1	2b	WMME019-05	Hydrogen, Fuels and Electrolysers	5	WE	No		dr. A. A. van der Meer	ir. T. Woudstra
1	2b	WMME035-05	Advanced Mechanical Dynamic Measurement	5	WE, P, AST	No		dr. L. Cheng	prof. dr. M. Ghandchi Tehrani
1	2b	WMME031-05	Composites and Metamaterials	5	AST, P, R, PR	Yes		dr. A.O. Krushynska	prof. dr. ir. B. Jayawardhana
1	2b	WMME023-05	Fracture of Materials	5	OR, AST	Yes		prof. dr. ir. E. van der Giessen	dr. F. Maresca
1	2b	WMME011-05	Data-driven Optimization	5	WE, AST	No		dr. A.K. Cherukuri	prof. dr. D. Bauso
1	2b	WMME015-05	Opto-Mechatronics	5	WE, AST	No		prof. dr. ir. B. Jayawardhana	prof. dr. ir. J.M.A. Scherpen
1	2b	WMME014-05	Medical Imaging Instrumentation	5	WE, AST	No		dr. P.G. Dendooven	dr. M. Kavatsyuk

- *Written Exam (WE)*
- *Multiple Choice (MC)*
- *Oral Exam (OR)*
- *Report (R)*
- *Presentation (P)*
- *Practical Work (PR)*
- *Assignment (AST)*

5. Relationship between course units and details of the learning outcomes

To give a better understanding of the knowledge gained by students in learning outcome 1.4 a description of the tracks is given.

The **Advanced Instrumentation** track focuses on two major themes. One is radiation instrumentation for science and healthcare, in collaboration with researchers based at *KVI-Center for Advanced Radiation Technology (KVI-CART)*, in collaboration with *University Medical Center Groningen*, who develop advanced instrumentation for various fields of scientific research as well as for healthcare (proton therapy). The second theme is Astronomical and Space Instrumentation which is developed together with researchers based at the *Netherlands Institute for Space Research (SRON)* and the *Kapteyn Institute*.

The **Smart Factories** track is developed together with the companies in the consortium *Innovation Cluster Drachten*. This track comprises of two study specializations, namely, specialization on materials for mechanical engineering and specialization on mechatronics, robotics and smart systems. These two specializations provide advanced knowledge and technologies that are crucial for smart factories, where the first one corresponds to the material engineering and the second one is related to the production and automation technologies. The University of Groningen is a partner in two of the Dutch Smart Industry field labs located in the north Netherlands: *Region of Smart Factories* and 5G *Groningen* and a partner in the Center of Expertise on Smart Sustainable Manufacturing. This consortium brings together multiple smaller and larger companies and universities in order to develop the factory of the future: intelligent, connected and customized production processes, for intelligent, connected and customized products. Researchers from the *Engineering and Technology institute Groningen (ENTEG)* and the *Zernike Institute for Advanced Materials (ZIAM)* participate in these field labs and contribute to this component of the education. The research institute *ENTEG* is an engineering science and technology institute that has the capability to analyse, explore and design new technologies that are based on the integration of fundamental and engineering sciences.

The **Smart and Green Energy Systems** track concentrates on the technologies for the production, storage and distribution of energy from renewable sources. It covers two main study concentrations, namely, the specialization on electrochemical systems that prepares students for the hydrogen economy critical to the energy transition agenda of EU and the specialization on renewable energy systems that prepares students for advanced knowledge and technologies related to renewable energy, such as, wind and wave energy. Together with *Healthy Ageing* and *Sustainable Society*, *Energy* is one of the three focal points of the University of Groningen where the transition from fossil fuels to sustainable energy sources is given special attention. This is why the university is a partner in the *Energy Academy Europe*, an international centre of excellence that brings together initiatives, partners and networks to facilitate acceleration of the energy transition. The importance of energy systems is also the prime focus of recently established Wubbo Ockels School of Energy and Climate at the University of Groningen.

The numbers in the top row of the tables refer to the learning outcomes as defined in section 3. A major contribution to the learning outcome is marked with an X, a minor contribution is marked with an x.

An X means that the learning outcome is explicitly assessed (not merely addressed) in the course.

		Learning outcomes of the degree programme																	
		1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	4.1	5.1	5.2
Period	**Course**	**ME core courses year 1**																	
1a	Introduction to Data Science	X						x					x	X		x		x	
1b	Computational Solid Mechanics	X	X	x				x	x		X								
2b	Experimental Design	X	x	X				X	X	X	X				x	X	X	x	
var	Course in Business, Management and Society					X		x	x					x	X		x	X	
var	Electives	x	x	x	x	x					x			x	x	x	x		
Period	**Course**	**ME core courses year 2**																	
Whole year	Master Research Project		X	X	x		X	X	X	X	x	x	X	X	X	X	X	x	x
Whole year	Master Design Project		x	x		x	X		x	x	x	X	X	x	x	x	X	x	X
Period	**Course**	**Advanced Instrumentation compulsory courses - Year 1**																	
1a	Basic Detection Techniques	X	x	x	X					X	X						X		X
1b	Advanced Instrumentation and Extreme Environments	X	X	x	X		X	X	x	x		x	X	X	x	x	X	x	x

		Learning outcomes of the degree programme																	
2a	Analysis and Control of Smart Systems	X	X	X			X	X	X	X									X
Period	**Course**	**Smart Factories compulsory courses - Year 1**																	
1a	Robotics for IEM	X	x		X		x		x					x		x			
1b	Advanced Processing for Complex Materials	X	x	X	X		x	x		X	X			x		X			
2a	Analysis and Control of Smart Systems	X	X	X			X	X	X	X									X
Period	**Course**	**Smart and Green Energy Systems compulsory courses - Year 1**																	
1a	Electrochemical Systems and Engineering	X	X		x			x	x		x								
2a	Thermodynamics of Energy Conversion	X		X				x	x		x								
2b	Advanced Process and Energy Technologies	X	x	x	X			x	x					x		x	x		

Appendix 1 - List of supervisors Master Projects

Supervisor	Research group
dr. A.G.P. Kottapalli	Advanced Production Engineering
prof. dr. Y. Pei	Advanced Production Engineering
prof. dr. J. Post	Advanced Production Engineering
prof. dr. R. Carloni	Artificial Intelligence
prof. dr. A.M. Barychev	Astronomy
prof. dr. R.F. Peletier	Astronomy
dr. E. Jurak	Bioproduct Engineering
prof. dr. M.J.E.C. Maarel, van der	Bioproduct Engineering
dr. P.J. Deuss	Chemical Technology
prof. dr. ir. H.J. Heeres	Chemical Technology
prof. dr. ir. W. Jong, de	Chemical Technology
prof. C.A. Bertoglio	Computational and Numerical Mathematics
prof. dr. ir. R.W.C.P. Verstappen	Computational and Numerical Mathematics
dr. A.O. Krushynska	Computational Mechanical and Materials Engineering
dr. F. Maresca	Computational Mechanical and Materials Engineering
prof. dr. A. Vakis	Computational Mechanical and Materials Engineering
dr. M.I. Acuautla Meneses	Discrete Technology and Production Automation

prof. dr. ir. M. Cao	Discrete Technology and Production Automation
dr. B. Haghighat	Discrete Technology and Production Automation
prof. dr. ir. B. Jayawardhana	Discrete Technology and Production Automation
prof. dr. ir. J.M.A. Scherpen	Discrete Technology and Production Automation
dr. E. Wilhelm	Discrete Technology and Production Automation
dr. S. Ahmed	Discrete Technology and Production Automation
prof. dr. M. Ghandchi Tehrani	Dynamics and Vibration
dr. L. Cheng	Dynamics and Vibration
dr. M. Muñoz Arias	Dynamics and Vibration
dr. A.V. Mokhov	Energy Conversion
prof. dr. A. Purushothaman Vellayani	Energy Conversion
dr. S. Brandenburg	Faculty of Medical Sciences
dr. P.G. Dendooven	Faculty of Medical Sciences
dr. ir. R. Fluit	Faculty of Medical Sciences
prof. A. Gerbershagen	Faculty of Medical Sciences
dr. E.R. van der Graaf	Faculty of Medical Sciences
prof. dr. M.J.H. Witjes	Faculty of Medical Sciences
dr. R.M.J. Benders	Integrated Research on Energy, Environment & Society
dr. K. Bunte	Intelligent Systems

dr. ir. J. Winkelman	Lecturers Chemistry
dr. ir. G.H. Jonker	Engineering Systems and Design Group
dr. ing. H. Kloosterman	Engineering Systems and Design Group
ir. T.M. Kousemaker	Engineering Systems and Design Group
dr. G.K.H. Larsen	Engineering Systems and Design Group
dr. N.B. Szirbik	Engineering Systems and Design Group
dr. W.P. Krijnen	Lecturers Mathematics
prof. dr. ir. E. Giessen, van der	Micromechanics
prof. dr. ir. P.R. Onck	Micromechanics
prof. dr. ir. B.J. Kooi	Nanostructured Materials and Interfaces
prof. dr. ir. V. Ocelik	Nanostructures of Functional Oxides
prof. dr. N. Kalantar-Nayestanaki	Nuclear Energy
prof. dr. D. Bauso	Optimization and Decision Systems
dr. A.K. Cherukuri	Optimization and Decision Systems
prof. dr. S. Hoekstra	Precision Frontier
dr. R.K. Bose	Product Technology
dr. ir. P.D. Druetta	Product Technology
dr. ir. M. Duin	Product Technology
prof. dr. C.E. Koning	Product Technology

dr. V. Kyriakou	Product Technology
dr. D. Parisi	Product Technology
prof. dr. P.P. Pescarmona	Product Technology
prof. dr. F. Picchioni	Product Technology
dr. P. Raffa	Product Technology
prof. dr. G.J.W. Euverink	Products and Processes for Biotechnology
prof. dr. C. De Persis	Smart Manufacturing Systems
dr. N. Monshizadeh Naini	Smart Manufacturing Systems
dr. ir. W. Jellema	Space Research
dr. ir. G. Lange, de	Space Research
prof. dr. M.A. Grzegorczyk	Stochastic Studies and Statistics
dr. ir. B. Besselink	Systems, Control and Applied Analysis
dr. M. Kavatsyuk	University College Groningen