HAN_UNIVERSITY OF APPLIED SCIENCES

Degree Statute for *Engineering Systems*

of HAN University of Applied Sciences academic year 2021 - 2022

Part 2 Education and Examination Regulations (EER)
chapter 6
Course catalogue

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1.1. Outline of the curriculum

TK Ŝ LJNJ ƨ Ŧ Ŝ ă ă ƛ ƨ y ˜ l· is offered as a full-time and a part-time degree course and covers 90 EC. 60 credits for the teaching phase, 30 of which are targeted at the study track, and 30 credits of the program are offered to all students jointly and 30 EC for the major project.
The full-time programme takes approximately 18 months, including the major project, based on a weekly study load of 40 hours and a break during the summer. Part-time takes approximately three years, based on a weekly study load of 20 hours, including the major project. The degree course is divided in modules of 15 EC.

The a l· ă ű Ŝ NJ Ω ă 5 Ŝ Engineering Systems offers 2 compulsory modules:

- Applied Control and
- Systems Modelling

We offer you the following elective modules grouped by tracks:

Tracks	Modules
Automotive Systems: Green mobility *Automotive Systems: Smart Mobility*	Advanced Vehicle Dynamics Electric, Hybrid & Fuel Cells Powertrains Hydrogen Technology Smart Infrastructure Smart Vehicles Sustainable Fuel Engines and Emissions
Control Systems	Big Data & Small Data Advanced Controller Design
Embedded Systems	Big Data & Small Data Distributed Systems
Lean Engineering	Process Development Product Development
Sustainable Energy	Big Data & Small Data Hydrogen Technology Smart Power Supply Sustainable Energy Systems

1.2. Competences / final qualifications and the Dublin descriptors

The competences (final qualifications) for the Master are defined as follows:

	Finalqualification	Description
C1	*Analyzing and defining problems*	To be able to critically analyze the engineering problem through active communication with the problem owner, to translate this a problem formulation, feasible solution approaches and scientifically valid conclusions and recommendations, to be communicated again to the problem owner.
C2	*Design*	To be able to systematically translate the engineering problem model at an abstract level, (i.e. reducing it to its essentials in te of model and problem requirements) and to validate results against the real life situation and problem formulation.
C3	*Testing*	To be able to systematically translate the engineering problem concrete level, and to validate results against the real life situat and problem formulation.
C4	*Managing work processes:*	To be able to put engineering activities within the perspective of engineering company processes, including quality control principles. To be able to incorporate the economical (cost) and societal (safety, sustainability) consequences in the design or development process.
C5	*Conducting research*	To have gained specialized scientific knowledge and skills in th field of engineering.
C6	*Communication and collaboration*	To be able to work on a problem within a multidisciplinary conte in an industrial environment. To be able to work on a problem in an international engineering context in an industrial environmer
C7	*Professional developmen*	To be able, through self NJ Ŝ Ŧ ť Ŝ Ŏ ǘ ƛ ƻ ƴ Σ ǘ ƻ ƛ Ƴ LJ professional acting

And the following Dublin descriptors:

	Dublin descriptor	Description
DD1	Knowledge and understanding	Provides a basis or opportunity for originality in developing or applying ideas often in a research context.
DD2	Applying knowledge and understanding	Through problem solving abilities applied in new or unfamiliar environments within broader (or multidisciplinary) context.
DD3	Making judgements	Demonstrates the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete data.
DD4	Communication	Of their conclusions and underpinning knowledge and rationale (restricted scope) to specialist and non-specialist audiences (monologue).
DD5	Learning skills	Study in a manner that may be largely self-directed or autonomous.

The modules (mentioned on page 3) consists of a number of units of study. All these study units relate to the qualifications (page 4) we intend to teach you. The description relates the content of an individual study unit to the qualifications, through the test criteria of the assessment of the study unit. These test criteria are included in the description as the learning outcomes. This relation between the criteria per study unit, the qualifications and the Dublin descriptors are summarized in Assessment why and how. As all modules together cover all qualifications, a completion of the modules with a sufficient mark entitles you to receive the degree Master of Science (MSc.).

1.3. Modules and the units of study

Below you find a schematic overview that gives you an overall impression of the degree program. It also describes the elective units in the degree program.

Units of study: mandatory (60 EC)

M SM	Module Systems Modelling			
Teaching Term	Semester 1 / semester 2			
Overview units of study	Units of Study		EC	study load
	M SM AP	Applied Physics	2.0	56
	M SM IM	Introduction Modelling	2.0	56
	M SM PMS	Practice Modelling and Simulation	2.0	56
	M SM EBM	Energy Based Modelling	2.0	56
	M SM SI	System Identification	2.0	56
	M SM MP	Systems Modelling Minor Project including Research Skills	5.0	140
			15	420

M AC	Module Applied Control			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M AC FC	Feedback Control	4.0	112
	M AC ACS	Apply Control Strategy	2.0	56
	M AC CI	Controller Implementation	2.0	56
	M AC MSO	Multivariable systems and optimizations	2.0	56
	M CD MP	Applied Control Minor Project	5.0	140
			15	420

M MAJP	Module Major Project			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M MAJP MP	Major Project	28	784
	M MAJP MWP	Managing Work Processes	2	56
			30	840

Modules and units of study:electives

Track Automotive:

M AVD	Module Advanced Vehicle Dynamics			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study /		EC	study load
	M AVD T	Advanced Vehicle Dynamics Theory	7.5	210
	M AVD CS	Advance Vehicle Dynamics Capita Selecta	2.5	70
	M AVD MP	Advanced Vehicle Dynamics Minor Project	5.0	140
			15	420

M EHFP	Module Electric Hybrid & Fuel cells Powertrain			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M EHFP T	Electric Hybrid & Fuel cells Powertrain Theory	7.5	210
	M EHFP CS	Electric Hybrid & Fuel cells Powertrain Capita Selecta	2.5	70
	M EHFP MP	Electric Hybrid & Fuel cells Powertrain Minor Project	5.0	140
			15	420

M HT2	Module Hydrogen Technology			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M HTT	Hydrogen Technology Theory	7.5	210
	M HTCS	Hydrogen Technology Capita Selecta	2.5	70
	M HTMP	Hydrogen Technology Minor Project	5.0	140
			15	420

M SI	Module Smart Infrastructure			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M SIT	Smart Infrastructure Theory	7.5	210
	M SICS	Smart Infrastructure Capita Selecta	2.5	70
	M SIMP	Smart Infrastructure Minor Project	5.0	140
			15	420

M SV	Module Smart Vehicles			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M SVT	Smart Vehicles Theory	7.5	210
	M SVCS	Smart Vehicles Capita Selecta	2.5	70
	M SVMP	Smart Vehicles Minor Project	5.0	140
			15	420

M SFEE	Module Sustainable Fuel Engines and Emissions			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M SFEE T	Sustainable Fuel Engines and Emissions T	5.0	140
	M SFEE I	Sustainable Fuel Engines and Emissions CS	5.0	140
	M SFEE MP	Sustainable Fuel Engines and Emissions Minor Project	5.0	140
			15	420

Track Control Systems:

M ACD	Module Advanced Controller Design			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M ACD T	Advanced Controller Design Theory	7.5	210
	M ACD CS	Advanced Controller Design Capita Selecta	2.5	70
	M ACD MP	Advance Control Minor Project	5.0	140
			15	420

M BDSD	Module Big Data & Small Data			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M BD DCML	Data Collection and machine learning	7.5	210
	M BD ASI	Apply Systems Identification (Capita Selecta)	2.5	70
	M BD MP	Big Data & Small Data Minor Project	5.0	140
			15	420

Track Embedded Systems:

M BDSD	Module Big Data & Small Data			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M BD DCML	Data Collection and machine learning	7.5	210
	M BD ASI	Apply Systems Identification (Capita Selecta)	2.5	70
	M BDMP	Big Data & Small Data Minor Project	5.0	140
			15	420

M DS	Module Distributed Systems			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M DS T	Distributed Systems Theory	7.5	210
	M DS CS	Distributed Systems Capita Selecta	2.5	70
	M DS MP	Distributed Systems Minor Project	5.0	140
			15	420

Track Lean Engineering

M PDD	Module Process Development			
Teaching Term	Semester 1			
Overview units of study	Units of Study		EC	study load
	M PDD OM	Process Development Operations Management	5.0	140
	M PDD FP	Process Development Factory Physics	2.5	70
	M PDD CS	Process Development Capita Selecta	2.5	70
	M PDD MP	Process Development Minor Project	5.0	140
			15	420

M PDD	Module ProductDevelopment			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M PDD MAP	Product Architecture Mapping	4.0	112
	M PDD PDD	Product Design and Development	3.5	98
	M PDDCS	ProductDevelopment Capita Selecta	2.5	70
	M PDDMP	ProductDevelopment Minor Project	5.0	140
			15	420

Track Sustainable Energy

M BDSD	Module Big Data & Small Data			
Teaching Term	Semester 1 / Semester 2			
Overview units of study	Units of Study		EC	study load
	M BD DCML	Data Collectionand machine learning	7.5	210
	M BD ASI	Apply Systems Identification (Capita Selecta)	2.5	70
	M BD MP	Big Data & Small Data Minor Project	5.0	140
			15	420

M HT2	Module Hydrogen Technology			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M HTT	Hydrogen Technology Theory	7.5	210
	M HTCS	Hydrogen Technology Capita Selecta	2.5	70
	M HTMP	Hydrogen Technology Minor Project	5.0	140
			15	420

M SPS	Module Smart Power Supplies			
Teaching Term	Semester 2			
Overview units of study	Units of Study		EC	study load
	M SPS EN	Energy Management	2.5	70
	M SPS PC	Power Control	2.5	70
	M SPS PQ	Power Quality	2.5	70
	M SPS AM	Asset Management	2.5	70
	M SPS MP	Smart Power Supplies Minor Project	5.0	140
			15	420

M SES	Module Sustainable Energy Systems			
Teaching Term	Semester 1			
Overview units of study	Units of Study		EC	study load
	M SES T	Sustainable Energy Technology	5.0	140
	M SES I	Energy System Integration	5.0	140
	M SES MP	Sustainable Energy Mind Project	5.0	140
			15	420

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Module code M AC	Applied Control
Degree program	Master Engineering Systems
Target Group	All students, mandatory
Coordinating Lecturer	Richard Kaandorp
Professional Task	Design and test a controller
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Simultaneously to the Module Systems Modelling or (for part time students) after taking classes Systems Modelling
General Description	In this module the student will gain knowledge on designing a PID, lag-lead or digital controller. Furthermore, the usefulness of a specific control strategy will be discussed using different papers. This strategy can solve problems that can occur when using the classical control theory. Finally, when having various options for defining a controller, an optimal path would be helpful. This can reduce cost for example and makes it necessary to define an objective function. The theory learned will be implemented in a platform and run on a practical setup. The student learns to design a controller for the practical setup in the following design steps and tasks: ¶ Creating a feedback controller ¶ Analyzing an uncontrolled system ¶ Applying an advanced control strategy ¶ Applying a controlled system
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Feedback Control (4 EC) Apply Control Strategy (2 EC) Controller Implementation (2 EC) Multivariable systems and optimizations (2 EC) Applied Control Project (5 EC)

Unit of Study (UoS) M AC FC	Feedback Control
General Information	
Name of unit of study	Feedback Control
Code for unit of study	M AC FC
Teaching Term	Semester 1 / Semester 2
Credits/study load	4 EC / 112 hours
Study hours (contact hours)	38 contact hours + 3 contact hours exam
Entry requirements	It is expected that the student has mastered basic mathematic skills specifically 1st and 2nd order differential equations, matrix calculations and calculations with complex numbers.
Objectives and instructional formats	
Professional task	Design feedback control
(Professional) products	Design of a classical controller with special-purpose software in respect to given performance criteria
General description	In this course students will learn how to design a PID-, lead-lag or digital controller. A variety of processes is used to illustrate the design procedure. The controllers will be presented in functional block diagrams and within the time, Laplace and frequency domain. Specific techniques are used, such as notch filtering, windup prevention and Smith predictor. Also, a digital controller will be designed.
Compulsory literature	Nise N.S., Control Systems Engineering, John Wiley & Sons Handouts Specific articles about control structures
Recommended literature	-
Required software	Matlab, Simulink
Relationship	Units of study: Applied Control Module: Systems Modelling
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments and exercises, Modelling with Matlab-Simulink Work Forms: Lectures, review exercises, discussion
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design of controllers
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems, design of controllers) - Applying knowledge and understanding (design of controllers) - Making judgements (design of controllers) The student can analyze the physical system (first and second order, higher order) and/or a model (linear/nonlinear, SISO/MIMO).

	The student can apply techniques such as Pole/zero plot and step/ramp responses in order to determine the requirements o the controlled system. The student can agree on specifications (stability, offset, settli time, overshoot, phase and gain margin) of the controller with the client. The student can apply techniques such as Bode plots (open l closed loop) and Nyquist diagrams in order to determine the requirements of the controlled system. The student can model components in the digital control loop and make use of sampling and conversions to agree on specifications of the controller. (M AC FC HTE)		
Assessment criteria	M AC FC WE assessment criteria: The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of t literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (f example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc. M AC FC HTE assessment criteria: The student will be assessed on the criteria mentioned on the evaluation form. (next page)		
Information for each exam and modular exam			
Examinations	Exam code	M AC FC WE	M AC FC HTE
		Week 1.9 /3.9	Week 2.9 and 4.9
	First examiner	Richard Kaandorp / Nico Bouwman / Stefan Sterkenburg	
	Exam method	Written exam	Home taken exam
	Permitted resources	Book Nise Computer with Matlab-Simulink	-
	Numberof examiners	1	1
	Assessment	mark	mark
	Pass mark	55	
	Minimal result	45	45
	Weight	1	1
	Reassessment	1	1
	Compensation	yes	
	Review	Week 2.4 and 4.4	Evaluation form week 3.4 and 4.12
Other information			
Required classroom	Regular classroom		

Feedback Control part 2: Digital Control

Evaluation and Awarding Marks
Name: X X X

Unit of Study (UoS) M AC ACS	Apply Control Strategies
General Information	
Name of unit of study	Apply Control Strategies
Code for unit of study	M AC ACS
Teaching Term	Term 2 / term 4
Credits/study load	2 EC / 56 hours
Studyhours (contact hours)	16 contact hours
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Apply control strategies
(Professional) products	Computer Simulations (case studies) based on scientific research literature
General description	In this course students learn how to design specific structures in which there is interaction between control loops. The goal is to improve the transient response behavior. The control strategy (feedforward, cascade, compensation, override) is used for a limited amount of control goals. The students will work on a few case studies that are based on scientific papers.
Compulsory literature	Handouts
Recommended literature	Scientific papers
Software and other materials	MATLAB/Simulink
Relationship	Units of study: Applied Control Module: Systems Modelling
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, warm-up tests, case studies Work forms: Lectures, interactive simulation exercises, assignments, reporting
Examinations	
Final Qualifications	C2 Design C5 Conducting Research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (design of controllers and testing of controlled systems) - Making judgements (testing controlled systems)

	The student can apply control strategies such as feedforward, cascade, compensation and override with use of frequency response and root-locus techniques.	
Assessment criteria	M AC ACS HTE assessment criteria: The student will be assessed on the criteria (the questions) mentioned on the evaluation form (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M AC ACS HTE
		Week 2.9 and 4.9
	First examiner	Richard Kaandorp
	Exam method	Home taken exam
	Permitted resources	Everything, but all results must ō Ŝ ű Ǩ Ŝ ă ű dz Ř Ŝ y˝ ú
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Evaluation form week 3.4 and 4.12
Other information		
Required classroom	Regular classroom	

Apply Control Strategies

Evaluation and Awarding Marks
Name, ŦřNJăúýlŶŜXXX

Unit of Study (UoS) M AC CI	Controller Implementation (Capita Selecta)
General Information	
Name ofunit of study	Controller Implementation
Code for unit of study	M AC CI
Teaching Term	Semester 1 / semester 2
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours
Entry requirements	Simultaneously to theModule SystemsModellingor after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Implement a controller
(Professional) products	Documentation
General description	In this course the implementation and evaluation of a controlle on different platforms (SIL, PIL, HIL) or for an application in vehicle dynamics control is set up. It is important to structure t program to keep a good overview. Also, safety should be ta into account. The programs Labview and Matlab Simulink can downloaded from internet. For PLC the Codesys software is provided. After a short introduction, a practical example is worked out and tested.
Compulsory literature	Lecturing material and handouts available on Onderwijs Online
Recommended literature	-
Software and other materials	Matlab, Simulink, Simmechanics, Labview, PLC, Hantune
Relationship	Units of study Systems Modelling Units of study Applied Control
Compulsory participation	yes
Activities and instructional formats	Home study, working on practical assignments Work forms: Lectures, interactive simulation exercises, assignments, reporting
Examinations	
Final Qualifications	C3 Testing controlled system
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (testing of controlled systems) - Making judgements (testing of controlled systems) - Communication (testing)

	- Learning skills (testing The student can implement, test and evaluate a controller on appropriate specific platform (e.g. SIL, PIL, HIL) for thermodynamic, hydraulic, mechanic processes or an application in vehicle dynamics and can check whether control specification are met.	
Assessment criteria	M AC CI HTE assessment criteria: The student will be assessed on the criteria mentioned on the evaluation form (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M AC CI HTE
		Week 2.10 and 4.10
	First examiner	Richard Kaandorp / Nico Bouwman /
	Exam method	Home taken exam
	Permitted resources	Everything, but all results must be ű Ƙ Ŝ ă ű dz Ř Ŝ ƴ ű Ω ă ƨ ø
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Evaluation form in week 3.4 and 4.12
Other information		
Required classroom	Control Systems lab	

Controller Implementation (Capita Selecta)

Evaluation and Awarding Marks

Name, first y˘ l· Y˘ Ŝ X X X

Unit of Study (UoS) M AC MSO	Multivariable systems and optimization
General Information	
Name of unit of study	Multivariablesystems and optimization
Code for unit of study	M AC MSO
Teaching Term	Term 1 / term 3
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours and 3contact hours exam
Entry requirements	It is expected that the student has mastered basic mathematics skills specifically differential equations and matrix calculations
Objectives and instructional formats	
Professional task	Controller optimization
(Professional) products	-
General description	This course covers the essential concepts of linear systems a control methodologies based on statespace models with (possibly) multiple inputs and multiple outputs. First, several structural properties are considered, such as input-output stability, internal stability, controllability and observability. Secondly, feedback strategies based on the state and the out are studied, and includes the notions of stabilizability and detectability, as well as the design of state observers and dynamic compensators. In the last part of the course, the theory of linear quadratic regulators (LQR) and the application of cos functions is introduced to optimally tune the feedback controllers. Computations, analysis and control designs will be mainly performed usinga l· ű f l· ō Ч ă á / ƨ ƴ ű NJ ƨ f { è to real-life systems. This course is complementary to the cours á C Ŝ Ŝ Ř ō l· Ŏ ļ / ƨ ƴ ű NJ ƨ f ɛ Σ ƛ Φ Ŝ Φ Σ ă function based analysis and design. Time-domain versus frequency domain approach ₡ ƨ Ǝ Ŝ ű Ƙ Ŝ NJ ø ƛ ű Ƙ ű / ƨ ƴ ű NJ ƨ f ɛ ű Ƙ ƛ ă Ŏ ƨ dz NJ ă Ŝ ø ƛ f f Ŧ world of control systems engineering and beyond.
Compulsory literature	Nise N.S., Control Systems Engineering, John Wiley & Sons Handouts / Manuals
Recommended literature	
Software and other materials	MATLAB/Simulink
Relationship	Units of study Systems Modelling Units of study Applied Control
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Working on practical assignments Work forms: Lectures, interactive simulation exercises, assignments

Examinations		
Final Qualifications	C1 Analyzing and defining problems C2 Design	
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing control systems) - Applying knowledge and understanding (designing control systems the student is able to ¶ identify whether a system is fully controllable, stabilizable, observable, detectable, and can check internal and input-output stability using state-space models; ¶ design pole-placement controllers and state observers; ¶ specify a cost function and to design an optimal dynam compensator.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of t literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (f example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M AC MSO WE
		Week 1.9 and 3.9
	First examiner	Dimitri Jeltsema / Richard Kaandorp
	Exam method	Written exam
	Permitted resources	Reader, lecture slides, computer with Matlab-Simulink
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Week 2.4 and week 4.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M AC MP	Applied Control Minor Project
General Information	
Name of unit of study	Applied Control Minor Project
Code for unit of study	M AC MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	28 contact hours and 4 contact hours presentation
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Development of a controller
(Professional) products	Controller implementation, documentation/presentation
General description	The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications. The project covers the following topics: ¶ The problem to be solved requires an understanding an active analysis of distinctive disciplines. ¶ The project will always include the step from a real-life problem to a more abstract representation of the proble ¶ physical system: PSpice, bode, step responses, linear/nonlinear; Control goals; Requirements: Stability, Offset, Settling time, Overshoot, Phase and gain margin SISO/MIMO; system engineering ¶ Controller design: [analog] PID, lead, lag, anti-windup, smith predictor, bumpless transfer. [digital] Euler/Tustin, zoh, sampling, PWM, bang-bang. The problem analysis will result in a problem solution to be translated in such terms that conclusions can be drawn based on the extent the problem has been solved and objectives fulfilled.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	Matlab Simulink
Relationship	Units of study Applied Control
Compulsory participation	Yes

Activities and instructional formats	Research Work Forms: Lectures, Assignment
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and defining problems, design of controllers, testing of controlled systems, conducting research) - Making judgements (analyzing and defining problems, design of controllers, testing of controlled systems, conducting research) - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validationare essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the interested public in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student can design and create an analog and/or digital feedback controller for linear physical system choosing appropri techniques (applying anti-windup and bumpless transfer schemes selecting resolution and sample rate).

<table>
<tr><td>Assessment criteria</td><td colspan="3">The student will be assessed on the criteria mentioned on the evaluation form.

To determine the result of the minor project for each student:

1. A group mark will be defined by the examiners.
2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. If the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not receive a pass and therefore no final grade.
3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review.

Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.</td></tr>
<tr><td colspan="4">Information for each exam and modular exam</td></tr>
<tr><td rowspan="11">Examinations</td><td>Exam code</td><td>M AC MP GC</td><td>M AC MP DP</td></tr>
<tr><td></td><td>Week 2.10</td><td>Week 2.10 and 4.10</td></tr>
<tr><td colspan="3">First examiner: Richard Kaandorp / Nico Bouwman / Sanket Dutt / Aishwarya Aswal</td></tr>
<tr><td>Exam method</td><td>Group contribution</td><td>Documentation / presentation</td></tr>
<tr><td colspan="3">Permitted resources: Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž NJ ł</td></tr>
<tr><td>Number of examiners</td><td colspan="2">2</td></tr>
<tr><td>Assessment</td><td>pass</td><td>Mark</td></tr>
<tr><td>Pass mark</td><td>pass</td><td>55</td></tr>
<tr><td>Minimal result</td><td>pass</td><td>55</td></tr>
<tr><td>Weight</td><td>0</td><td>1</td></tr>
<tr><td>Reassessment</td><td colspan="2">1, week 4.11 / 4.12</td></tr>
<tr><td>Compensation</td><td colspan="2">No</td></tr>
<tr><td colspan="3">Review: Feedback after presentation / evaluation form in week 3.4 and 4.12</td></tr>
<tr><td colspan="4">Other information</td></tr>
<tr><td>Required classroom</td><td colspan="3">Control systems lab</td></tr>
</table>

Project Applied Control: Project Documentation and Presentation
Evaluation and Awarding Marks

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Communication C4:Managing work processes C6: Communication and Collaboration The student can communicate his project findir and defend choices in a clear and structured manner in oral and written forms. The student is able to present the results to a problem owner. Thestudent is able to work in a project team. The text is clearly understandable and in grammatically sound language. The formal requirements for literary sources ha been met.			1
Learning Skills C7: Professional development The student is able to reflect on his role in the project and on his professional development. Does the student display discernible eagerness tackle the task? The problem owner is involved adequately. The student shows problem solving skills. The student is self-reliant. Thestudent reflects on the choices made.			1
Final Mark (group) For a pass all marks should be sufficient			

Date :

Name and signature examiner 1 :

Name and signature examiner 2 :

Module code M SM	Systems Modelling
Degree program	Master Engineering Systems
Target Group	All students, mandatory
Coordinating lecturer	Frank Poelmans
Professional Task	Modelling Systems
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	First module after admission to the program (basic module)
General Description	In this module the student will gain knowledge on analyzing physical systems in the mechanical, electrical and thermodynar fluid dynamic domains. Models forphysical systems will be established by using white b modelling and by using experimental data. Furthermore computer simulations of established models will be performed to analyze the systems behavior. The models will be validated by collecting relevant datasets or designing a validation experiment. Finally the theory learned will be implemented in a modelling ca where the student also learns to evaluate relevant literature on modelling and learns to create a report and a presentation on the modelling-simulation-validation process.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Applied Physics (2 EC) Introduction Modelling (2 EC) Energy Based Modelling (2 EC) Practice Modelling and Simulation (2 EC) System Identification (2 EC) Modelling Systems Project (5 EC)

Unit of Study (UoS) M SM AP	Applied Physics
General Information	
Name of unit of study	Applied Physics
Code for unit of study	M SM AP
Teaching Term	Term 1 / term 3
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours + 3 contact hours exam
Entry requirements	It is expected that the student has mastered basic mathematics skills specifically differential equations.
Objectives and instructional formats	
Professional task	Analyze physical systems
(Professional) products	-
General description	The course Applied Physics (AP) covers the following topics: Mechanical systems: ¶ Dynamics and kinematics of general motion of a body (translations, rotations, moment of inertia, transmissions energy conservation) ¶ Vibrations with multiple DOF (free vibrations, excited vibrations) ¶ 1st and 2nd order mechanical systems Electrical systems: ¶ Electrical networks ¶ Operational amplifier circuits ¶ Electromechanical systems Thermodynamic/Fluid dynamic systems: ¶ Energy balances, mass balances ¶ Heat transfer, Bernoulli flow equation ¶ 1st law and 2nd law of thermodynamics ¶ Reversible changes of ideal gas, thermodynamic diagra
Compulsory literature	¶ Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th edition, International Student Version (2011) ¶ Engineering Mechanics: Dynamics SI Edition, R.C. Hibbeler, 14th Edition, Pearson, ISBN 9781292088721 ¶ Norman S. Nise, Control Systems Engineering, 8th editi (EMEA edition), Wiley, ISBN 978-1-119-590132 ¶ Reader Introduction Dynamics, E. Tazelaar et al, HAN, ¶ Lecturing material available on Onderwijs Online
Recommended literature	¶ Transport Phenomena, The art of Balancing H. vd Akker, R.F. Mudde, Delft Academic Press, ISBN 9789065623584
Required software	-
Relationship	Units of study Systems Modelling

Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Self-study, Working on assignments and exercises Work Forms: Lectures	
Examinations		
FinalQualifications	C1 Analyzing and defining problems	
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems) The student is able to analyze moderately complex physical systems in the mechanical, electrical and/or thermodynamic/fluid dynamic domains by describing the systems with differential equations. The system descriptions are found via white box modeling.	
Assessment criteria	The student will be assessed on answering the questi ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M SM AP WE
		Week 1.9 and 3.9
	First examiner	Frank Poelman / Joke Westra / Aishwarya Aswal
	Exam method	Written exam
	Permitted resources	calculator
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Week 2.4 and 4.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SM IM	Introduction Modelling
General Information	
Name of unit of study	Introduction Modelling
Code for unit of study	M SM IM
Teaching Term	Term 1 / term 3
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours + 3 contact hours exam
Entry requirements	It is expected that the student has mastered basic mathematics skills specifically Differential equations, Linear algebra, Laplace transforms and Complex numbers.
Objectives and instructional formats	
Professional task	Analyze physical systems
(Professional) products	Models
General description	The course Introduction Modelling (IM) covers the following topics: ¶ Modelling goals, process definitions, data flow diagram ¶ 4+1 step approach ¶ Model equations and mathematical solutions ¶ Conversion of differential equations into transfer functions ¶ Model simulation (Simulink, pole-zero map, step-response, bode plot) ¶ Conversion of differential equations into state space models ¶ Process delays, nonlinear systems ¶ Introduction to multi domain systems
Compulsory literature	¶ Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th edition, International Student Version (2011) ¶ Norman S. Nise, Control Systems Engineering, 8th edition (EMEA edition), Wiley, ISBN 978-1-119-59013-2 ¶ Reader Introduction Dynamics, E. Tazelaar et al, HAN, ¶ Lecturing material available on Onderwijs Online
Recommended literature	-
Software and other materials	Matlab, Simulink
Relationship	Units of study Systems Modelling
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments, Simulation exercises, Cas studies Work Forms: Lectures

Examinations		
Final Qualifications	C1 Analyzing and defining problems C2 Design	
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems) - Applying knowledge and understanding (Design physica systems) The student is able to analyze moderately complex physical systems in the mechanical, electrical and/or thermodynamic/fluid dynamic domains by describing the systems with either different equations, transfer functions, state-space models or Bode diagrams in order to determine the system characteristics and b able to perform computer simulations. The student is able to describe the system using methods like white box modelling or step response experiments assuming lowest possible complexi for the analysis of relevant system characteristics.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M SM IM WE
		Week 1.9 and 3.9
	First examiner	Richard Kaandorp / Marijn Jongerden / Mitul Saini
	Exam method	Written exam
	Permitted resources	Calculator, book CSE author Nise
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Week 2.4 and 4.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SM PMS	Practice Modelling and Simulation
General Information	
Name of unit of study	Practice Modelling and Simulation
Code for unit of study	M SM PMS
Teaching Term	Term 1 / term 3
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours
Entry requirements	There are no further entry requirements after admission
Objectives and instructional formats	
Professional task	Analyze physical systems
(Professional) products	Computer simulations and analysis
General description	PMS covers model assignments and simulations with Matlab-Simulink. ¶ General software introduction in Matlab, Simulink ¶ Simulation and analysis a system using different models (i.e. differential equations, state-space and transfer functions) ¶ Analysis of basic cases (exercises at HAN, home taken each student separately) based on the domains treated in AP and IM (i.e. mechanical, electrical and thermodynamic/fluid dynamic) ¶ Performing system verification and validation ¶ Perform parametric analysis on systems for using loops. ¶ Creating an efficient connection between scripting and Simulink modelling ¶ Effectively plotting relevant data
Compulsory literature	Lecturing material and hand-outs available on Onderwijs Online
Recommended literature	-
Softwareand other materials	Matlab, Simulink
Relationship	Units of study Systems Modelling
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Home study, working on practical assignments Work forms: Lectures, interactive simulation exercises, assignments, reporting, presentations
Examinations	

Final Qualifications	C2 Design C3 Testing	
Assessment dimensions / Learning outcomes	Dimensions of assessment: Applying knowledge and understanding (designtesting) The student is able to analyze, model, verify and validate a given system (in terms of differential equations) which can be from different application fields (i.e. mechanical, electrical and thermodynamic/fluid dynamic) in modelling software (*e.g. Matlab, Simulink or similar tools).* The student is able to convert the system into different models i.e. state-space and transfer function models. The verification is performed with logical inputs along with log references. The validation is done by importing, filtering and comparing relevant datasets with the model data and/or by performing sensitivity analysis on the system parameters.	
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M SM PMS HTE
		Assignment: week 1.5 and 3.5 Hand in: week 1.9 and 3.9
	First examiner	Hatim Mala / Mitul Saini
	Exam method	Home taken exam
	Permitted resources	Everything, but all results must be ú Ķ Ŝ ă ű dz Ř Ŝ y˝ ú Ω ă ž ø
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Evaluation form in week 2.4 and 4.4
Other information		
Required classroom	Regular classroom	

Practice Modelling and Simulation

Evaluation and Awarding Marks
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Unit of Study (UoS) M SM EBM	Energy Based Modelling
General Information	
Name of unit of study	Energy based Modelling
Code for unit of study	M SM EBM
Teaching Term	Term 2 / term 4
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours and 3 contact hours exam
Entry requirements	It is expected that the student has mastered basic mathematic skills specifically differential equations and matrix calculations
Objectives and instructional formats	
Professional task	Analyze physical systems
(Professional) products	Models
General description	The course Energy Based Modelling (EBM) covers the followi topics: ¶ Introduction to Energy Based Modelling ¶ Generalized variables and coordinate transformations ¶ Energy and power functions ¶ Euler-Lagrange equation ¶ I l· Y ƛ ƭ ǘ ƻ ƴ Ω Ǎ ƭ ƛ ƴ ƛ ƴ ƛ ƴ ƭ Ŝ Σ ¶ Modelling complex systems in mechanical and electric domain ¶ Modelling multi-domain systems
Compulsory literature	Lecturing material and hand-outs, available on Onderwijs Online
Recommended literature	-
Software and other materials	-
Relationship	Units of study Systems Modelling
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments and exercises Work Forms: Lectures
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C5 Conducting Research
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems, conducting research) - Applying knowledge and understanding (design)

	The student is able to analyze complex mono/multi-physical systems in the mechanical, electrical and/or thermodynamic/fluid dynamic domains by describing the system with either differential and algebraic equations, transfer functions or state-space representations. The system descriptions are found via advanced white box modeling based on the internal energy of the system.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M SM EBM WE
		Week2.9 and 4.9
	First examiner	Dimitri Jeltsema / Frank Poelmans
	Exam method	Written exam
	Permitted resources	Calculator, handouts
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Week 3.4 and week 4.12
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SM SI	System Identification
General Information	
Name of unit of study	System Identification
Code for unit of study	M SM SI
Teaching Term	Term 2 / term 4
Credits/study load	2 EC / 56 hours
Study hours (contact hours)	16 contact hours
Entry requirements	There are no further entry requirements after admission to the program
Objectives and instructional formats	
Professional task	Analyze data and validate model structures
(Professional) products	Models
General description	Topics: ¶ Data use ¶ Parameter estimation ¶ Sensitivity analysis ¶ Validation
Compulsory literature	¶ Reader System Modelling, Data Regression and System Identification, ¶ Lecture notes, P. van Kan, HAN 2018 ¶ Lecturing material available on Onderwijs Online
Recommended literature	-
Software and other materials	Matlab
Relationship	Units of study Systems Modelling
Compulsory participation	No, butattendance will be registered
Activities and instructional formats	Self-study, working on assignments Work forms: lectures
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C6 Communication and collaboration

Assessment dimensions / Learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (Analyzing and defining problems) ¶ Applying knowledge and understanding (Design) ¶ Communication (Reporting) The student is able to demonstrate understanding of systems identification on an introductory level regarding data and model structure. The student is able to estimate parameters in a linear/nonlinear systems model from real measurement data using (weighted) least-squares methods. The student is able to evaluate a model structure based on output data and goodness of fit. The student communicates the findings of the assignment in a clear and structured manner in written form.	
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M SM SI HTE
		Assignment: week 2.6 and 4.6 Hand in: week 2.9 and 4.9
	First examiner	Paul van Kan / Hatim Mala
	Exam method	Home taken exam
	Permitted resources	Everything, but all results Ÿ dz ă ű ō Ŝ ű K Ŝ a work
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Evaluation form in week 3.4 and 4.12
Other information		
Required classroom	Regular classroom	

System Identification

Evaluation and Awarding Marks
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Unit of Study (UoS) M SM MP	Modelling Systems Minor Project
General Information	
Name of unit of study	Modelling Systems Minor Project
Code for unit of study	M SM MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	28 contact hours and 4 contact hours presentation
Entry requirements	There are no further entry requirements after admission to the program
Objectives and instructional formats	
Professional task	Evaluate relevant literature and Analyze and validate the model
(Professional) products	Model Report(Literature review) Presentation
General description	The students have to carry out an assignment, of which model development and analysis as well as experimental validation a essential parts. The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications and t course discusses the skills needed to perform a research proj and includes performing a literature study.
Compulsory literature	B. Hanington, B. Martin, *Universal Methods of Design*, Rockport Publishers Inc. 2012 Project Management, A Practical Approach, Roel Grit, Noordh Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591 Card Set Research Skills, HAN Campusstore
Recommended literature	-
Software and other materials	Matlab Simulink
Relationship	Units of study Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment

Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment - Knowledge and understanding (Conducting Research) - Applying knowledge and understanding (Analyzing and defining problems, Design, Conducting Research) - Making judgements (Analyzing and defining problems, Design, Conducting Research - Communication (Managing work processes, Communication and Collaboration) - Learning skills (Professional development) Learning outcomes: The student presents a clear justification of the project approa The student plans effectively(M SM MP PP). The student carries out a project based on a real-life problem in which model development and analysis as well as experiment validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The system descriptions are found via white box modeling or step response experiments The student structures the working process in the engineering domain and is able to effectively communicate the core finding in a structured and convincing way. The student is able to systematically search for information, s as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms. The content has been reviewed by peers and/or supervisor The student reflects on his/her role in the project and on his/her professional development (M SM MP RP).
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners.

	2. Peer review: each minor project group evaluates at least twice the contribution of the group members on conter and collaboration. if the outcome of the first peer review is negative for the individual student, the student still h the opportunity to improve. If the result is negative agai during the second peer review, the student will not receive a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.			
Information for each exam and modular exam				
Examinations	Exam code	M SM MP PP	M SM MP GC	M SM MP RP
		Week 1.9 Week 3.9	Week 2.10 / 4.10	Week 2.9/2.10 4.9/4.10 Report/Pres
	First examiner	Frank Poelmans / Keun Young van Sliedrecht		
	Exam method	Project Plan	Group contri-bution	Report and Presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ ƴ ű Ω ă ƻ ǿ ƴ ǿ ƻ NJ ʅ		
	Number examiners	1	2	2
	Assessment	Pass	pass	mark
	Pass mark	pass	pass	55
	Minimal result	pass	pass	55
	Weight	0	0	1
	Reassessment	1 (2.2 / 4.2)	1 (4.11 / 4.12)	
	Compensation	no	No	
	Review	Evaluation form in week 2.4 and 4.4	Feedback after presentation / evaluation form in week 3.4 and 4.12	
Other information				
Required classroom	Regular classroom			

Project Systems Modelling: Project plan

Evaluation and Awarding Marks

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Do the students display discernible keenness to tackle the task (initiative, deadline handling?) Is the problem owner involved adequately?			
Pass total For a pass all items should be sufficie			

Date :

Signature examiner :

Project Systems Modelling: Report and Presentation

Evaluation and Awarding Marks

Name, first y˙ l· Y˙ Ŝ X X X

Collaboration Can the student communicate his project findings and defend choices in a clear and structured manner in oral and written forms? Is the student able to present the result to a problem owner? Is the student able to work in a project team? Is the text clearly understandable and in grammatically sound language? Have the formal requirements for literary sources been met?			
Learning Skills C7: Professional development is the student able to reflect on his role in the project and on his professional development? Does the student displays discernible eagerness to tackle the task? Is the problem owner involved adequately? Does the student show problem solving skills? Is the student self-reliant? Does the student reflect on the choices made?			
Final Mark (group) For a pass all marks should be sufficient			

Date :

Signature examiner :
Signature examiner :

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Module code M ACD	Advanced Controller Design
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Dimitri Jeltsema
Professional Task	Analyze, synthesize and apply advanced control methods
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Applied Control Systems Modelling
General Description	This module deals with modelling, analysis and control of nonlinear, timevarying and uncertain systems. This module learns the student to: ¶ distinguish between linear and nonlinear systems properties; ¶ decide when to apply linear and when to apply nonlinear theory; ¶ determine several stability properties for nonlinear systems; ¶ apply energy-based concepts for stabilization; ¶ determine controllability and observability properties for nonlinear systems; ¶ design linearizing feedback transformations; ¶ formulate and synthesize optimal control problems; ¶ apply robust, adaptive and predictive control methods; ¶ work in both continuous and discrete time settings.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Advanced Controller Design Theory (7.5 EC) Advanced Control Design Capita Selecta (2.5 EC) Advanced Control project (5.0 EC)

Unit of Study (UoS) M ACD T	Advanced Controller Design Theory
General Information	
Name of unit of study	Advanced Controller Design Theory
Code for unit of study	M ACD T
Teaching Term	Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours
Entry requirements	Applied Control and Systems Modelling
Objectives and instructional formats	
Professional task	not applicable
(Professional) products	not applicable
General description	The student learns how to apply several linear and nonlinear analysis and control techniques to different nonlinear processes and simulate them using Matlab.
Compulsory literature	Lecturing material (readers, papers and handouts) will be made available on Onderwijs Online
Recommended literature	-
Required software	Matlab / Simulink
Relationship	Module Applied Control Module Systems Modelling
Compulsory participation	No, butattendance will be registered
Activities and instructional formats	Self-study, case-studies, working on practical assignments. Work forms: Lectures, interactive simulation exercises, assignments, reporting practical assignments.
Examinations	
FinalQualifications	C2 Design of controllers
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analysis) - Applying knowledge and understanding (design of controllers) The student is able to apply and evaluate various linear techniques applied to nonlinear systems. The student is able to carry out a basic analysis of nonlinear systems. The student is able to apply energy-based modelling and control to various real-life systems.M ACD T HTE1

	The student is able to apply adaptive, robust and optimal control techniques to linear and nonlinear systems. The student is able to carry out further analysis of nonlinear systems. (M ACHTE2)		
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form. (next page)		
Information for each exam and modular exam			
Examinations	Exam code	M ACD THTE1	M ACD THTE2
		Week 3.9	Week 4.9
	First examiner	Dimitri Jeltsema / Hatim Mala / Aad Jan de Graaf	
	Exam method	Home taken exam	Home taken exam
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž NJ ł	
	Number of examiners	1	1
	Assessment	Mark	Mark
	Pass mark	55	
	Minimal result	45	45
	Weight	1	1
	Reassessment	4.4	August 15
	Compensation	yes	
	Review	Evaluation form in week 3.4	Evaluation form in week 4.12
Other information			
Required classroom	Regular classroom		

Theory classes of advanced controller design
Evaluation and Awarding Marks
Name, first y˘ l· Y˘ Ŝ X X X

Unit of Study (UoS) M ACD CS	Advanced Controller Design Capita Selecta
General Information	
Name of unit of study	Advanced Controller Design Capita Selecta
Code for unit of study	M ACD CS
Teaching Term	Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	32 contact hours
Entry requirements	Applied Control and Systems Modelling
Objectives and instructional formats	
Professional task	Implement a controller
(Professional) products	Literature study report in the form of an article to inform pea students.
General description	Study various linear and nonlinear control techniques and a ű ǿ ƻ LJ l· NJ ű ƛ Ŏ dz ƭ l· NJ ƻ ƴ Ŝ ă ó ă ű dz Ř Ŝ y setup designed in the Mind Project.
Compulsory literature	To be decided during class, depending on the subject.
Recommended literature	To be decided during class, depending on the subject.
Software and other materials	-
Relationship	Units of study Advanced Controller Design
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, case studies Work forms: Lectures, interactive simulation exercises, assignments, reporting
Examinations	
Final Qualifications	C5Conducting research
Assessment dimensions / Learning outcomes	Dimensions of assessment: - knowledge and understanding (conducting research and Professional Development) - Applying knowledge and understanding (conducting research) - Making judgements (conducting research) - Communication (conducting research) - Learning skills (conducting research)

	The student shows how to implement and evaluate control methodologies in a real-life environment.	
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form.	
Information for each exam and modular exam		
Examinations	Exam code	M ACD CS
		Week 4.6
	First examiner	Dimitri Jeltsema / Hatim Mala / Aart-Jan de Graaf
	Exam method	Home taken exam: Article
	Permitted resources	Everything, but all results Ÿ dz ă ű ō Ŝ ű Ќ Ŝ à work
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	Week 4.11 / 4.12
	Compensation	no
	Review	Evaluation form in week 4.10
Other information		
Required classroom	Regular classroom	

Advanced Controller Design Capita Selecta

Evaluation and Awarding Marks

	Mark	Motivation	Weight factor
Knowledge and understanding C5: Conducting Research Provides a basis or opportunity for originality in developing or applying ideas often in a research context			1
Applying knowledge and understanding C5: Conducting Research Through problem solving abilities applied in new or unfamiliar environments within broader (or multidisciplinary) context.			1
Making judgments C5: Conducting Research Demonstrates the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete data.			1
Communication C5: Conducting Research Of their conclusions and underpinning knowledge and rational (restricted scope) to specialist and non-specialist audiences (monologue).			1
Learning Skills C5: Conducting Research Study in a manner that may be largely self-directed or autonomous.			1
Mark total			

Date :

Signature examiner :

Unit of Study (UoS) M ACD MP	Advanced Controller Design Minor Project
General Information	
Name of unit of study	Advanced Controller Design Minor Project
Code for unit of study	M ACD MP
Teaching Term	Semester 2
Credits/study load	5.0 EC / 140 hours
Study hours (contact hours)	64 contact hours and 4 contact hours presentation
Entry requirements	Applied Control and Systems Modelling
Objectives and instructional formats	
Professional task	Synthesis of a control system in incremental steps
(Professional) products	Controllerimplementation Project documentation, Presentation
General description	The project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications. The problem to be solved requires application of advanced control theory to real-life problems.
Compulsory literature	¶ Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 ¶ Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	Matlab / Simulink. Students will build their own Arduino-based control system. Please reserve (approximately) 100 euro to order the required components and materials.
Relationship	Module Systems Modelling Module Applied Control
Compulsory participation	yes
Activities and instructional formats	Research Work Forms: Lab sessions and assignments Development of a control system.
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes

	C5Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Assessment dimensions: ¶ Applying knowledge and understanding (analyzing and defining problems, design, testing, conducting research) ¶ Making judgements (analyzing and defining problems, design, testing, conducting research) ¶ Communication (managing work processes, communication and collaboration) ¶ Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approach. The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings in a structured and convincing way. Thestudent is able to systematically search for information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms.The content has been reviewed by peers and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student evaluates, justifies and applies various linear and nonlinear analysis and control techniques for a given process.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again

	during the second peer review, the student will not rece a pass and therefore n final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their pro group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M ACD MP GC	M ACD MP DP
		Week 4.9 / 4.10	
	First examiner	Dimitri Jeltsema / Hatim Mala	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be ű K Ŝ ă ű dz Ř Ŝ y˝ ű Ω ă ž ó	
	Number of examiners	2	2
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	Week 4.11 / 4.12	
	Compensation	No	
	Review	Feedback after presentation / evaluation form in week 4.12	
Other information			
Required classroom	Control systems lab		

Advanced Controller Design: Project Documentation and Presentation: Evaluation and Awarding Marks

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Module code M AVD	Advanced Vehicle Dynamics
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Saskia Monsma
Professional Task	Model and validate linear and nonlinear vehicle dynamics
Professional Products	Project plan Report Model + data Presentation (progress and final)
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Systems Modelling and Applied Control
General Description	The module covers: modeling and validation of vehicle dynamics: linear and nonline steady state and non-steady state, without and with (driver) control, emphasizing tires, driver, passenger cars, articulated vehicles and motorcycles.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units ofstudy	Advanced Vehicle Dynamics Theory 7.5 EC Advanced Vehicle Dynamics Capita Selecta 2.5 EC Advanced Vehicle Dynamics Minor Project 5.0 EC

Unit of Study (UoS) M AVD T	Advanced Vehicle Dynamics Theory
General Information	
Name of unit of study	Advanced Vehicle Dynamics Theory
Code for unit of study	M AVD T
Teaching Term	Semester 1 / Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours + 3 contact hours exam (written exam AVD1 and 20 minutes oral exam AVD2)
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Model linear and nonlinear vehicle dynamics
(Professional) products	Not applicable
General description	The study unit covers modeling of vehicle dynamics: linear and nonlinear, steady state and non-steady state, without and with (driver) control, emphasizing tires, driver, passenger cars, articulated vehicles and motorcycles.
Compulsory literature	Alessandro Genta and Giancarlo Genta, Road Vehicle Dynamics, Fundamentals of Modeling and Simulation, 2016, World Scientific, ISBN 9814713430, 9789814713436 Lecturing material and handouts, available on OnderwijsOnline
Recommended literature	Joop P Pauwelussen, Essentials of Vehicle Dynamics, 2014, Butterworth-Heinemann, ISBN: 9780081000366 R.J. Jagacinski, J.M. Flach, *Control Theory for Humans*, ISBN nr. 0805822925 V. Cossalter, *Motorcycle Dynamics*, 2nd edition (2006), ISBN nr. 97 ς1 ς4303 ς0861 ς4 P.Sweatman (ed.), *PBS Explained, Performance Based Standard for Road Transport Vehicles*, report Australian Road Transport Suppliers Association (2003)
Required software	Matlab/Simulink
Relationship	Advanced Vehicle Dynamics: Capita Selecta and Minor Project

Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments Work Forms: Lectures (flipped classroom)
Examinations	
Final Qualifications	C1 Analyzing and defining problems
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems) The student is able to analyze, synthesize and evaluate (M AVD WE): ¶ linear and nonlinear tire dynamics and models, including main influences like load transfer, combined slip, cambe suspension characteristic ¶ steady state vehicle handling based on the single track vehicle model including nonlinear tire models ¶ vertical vehicle dynamics related to road input The student is able to analyze, synthesize and evaluate (M AVD OE): ¶ steady state and non-steady state dynamics of tires, passenger vehicles, articulated vehicles and motorcycle ¶ closed-loop driver vehicle system dynamics and modeling with the preview driver model.
Assessment criteria	The student will be assessed (M AVD WE and M AVD OE) on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc. M AVD WE and M AVD OE: The WarmUp Test result given by t lecturer during the lecturing of the theory determines 20% of the score of the written (re-) exam M AVD WE and 20% of the oral (re-)exam M AVD OE. There are no separate WarmUp Tests fo re-exams.
Information for each exam and modular exam	

Examinations	Exam code	M AVD WE	M AVD OE
		Week 1.9 / 3.9	Week 2.9 / 4.9
	First examiner	Saskia Monsma / Thymen Kamerling / Ka Kural / Mitul Saini / Rene Gerritsen	
	Exam method	Written exam	Oral exam
	Permitted resources	Simple scientific calculator	none
	Number of examiners	1	2
	Assessment	Mark	Mark
	Pass mark	55	
	Minimal result	45	45
	Weight	1	1
	Reassessment	1	1
	Compensation	yes	
	Review	Week 2.4 / 4.12	Feedback on the same day / evaluationform week 3.4 and 4.12
Other information			
Required classroom	Regular classroom		

Advanced Vehicle Dynamics T (oral part)

Evaluation and Awarding Marks
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Unit of Study (UoS) M AVD CS	Advanced Vehicle Dynamics Capita Selecta
General Information	
Name of unit of study	Advanced Vehicle Dynamics Capita Selecta
Code for unit of study	M AVD CS
Teaching Term	Semester 1 / Semester 2
Credits/study load	2.5 EC / 56 hours
Study hours (contact hours)	16 contact hours
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Model and validate vehicle dynamics
(Professional) products	Documentation of the work, like report, models, data and/or presentation and defense
General description	The theory of AVD is deepened and extended with relevant, actual topics, for example - vehicle modeling and simulation - control applications in AVD - tire design and performance - race car data analysis - scientific papers on AVD This will be done with different work forms, for example: - guest lectures from industry and/or research - modelling and simulation assignments - review and presentation of scientific papers - workshops
Compulsory literature	Handouts
Recommended literature	-
Software and other materials	Matlab/Simulink
Relationship	Modules Systems Modelling and Applied Control
Compulsory participation	Yes
Activities and instructional formats	Self-study, case studies Work forms: Lectures, interactive simulation exercises, assignments, reporting
Examinations	

Final Qualifications	C2 Design C5 Conducting Research	
Assessment dimensions / Learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (conducting research) ¶ Applying knowledge and understanding (conducting research) The student has gained deepened and /or applied scientific knowledge and skills in the topics covered in this Capita Selec	
Assessment criteria	The student will be assessed on their assignment results be ¶ clearly and to the point, including sufficient relevant explanation and depth as stated in the assignment ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M AVD CS
		Week 2.9 and 4.9
	First examiner	Saskia Monsma / Mitul Saini / Thymen Kamerling / Karel Kura
	Exam method	Home taken exam
	Permitted resources	Everything, but all results must ō Ŝ ű Ƙ Ŝ ă ű dz Ř Ŝ y ű
	Number of examiners	1
	Assessment	Mark (= mean of all assignmen marks)
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Review week 3.3 and 4.12
Other information		
Required classroom	Regular classroom	

Advanced Vehicle Dynamics: Capita Selecta

Evaluation and Awarding Marks

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Unit of Study (UoS) M AVD MP	Advanced Vehicle Dynamics Minor Project
General Information	
Name of unit of study	Advanced Vehicle Dynamics Minor Project
Code for unit of study	M AVD MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	20 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Model and validate linear and nonlinear vehicle dynamics
(Professional) products	Model, report, presentation and defense
General description	Students have to carry out an assignment including a literature survey, of which model development and analysis as well as (vehicle instrumentation and) experimental validation and parameter identification are essential parts. Examples are: ¶ To improve a chassis design through damper adjustment ¶ To derive and validate an experimental way to identify and analyze driver control parameters (gains, lead and lag times, delay time,..)
Compulsory literature	¶ Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 ¶ Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	Matlab/Simulink
Relationship	Units of study Advanced Vehicle Dynamics Units of study Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, assignment, lab/testing guidance, supervisor meetings
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research

	C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment ¶ Applying knowledge and understanding (Analyzing and defining problems, Design, Conducting Research) ¶ Making judgements (Analyzing and defining problems, Desi Conducting Research ¶ Communication (managing work processes, communicatior and collaboration) ¶ Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider pub in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still ha the opportunity to improve. If the result is negative again during the second peer review, the student will not recei a pass and therefore no final grade.

	3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M AVD MPGC	M AVD MP DP
		Week 2.9/2.10 and 4.9/4.10	
	First examiner	Saskia Monsma / Thymen Kamerling / Mitul Saini / Rene Gerritsen	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be ű K Ŝ ă ű dz Ř Ŝ y˝ ű Ω ă 2	
	Number of examiners	2	
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	1, week 4.11 / 4.12	
	Compensation	No	
	Review	Feedback after presentation / evaluation form in week 3.4 and 4.12	
Other information			
Required classroom	Regular classroom and lab		

Project Advanced Vehicle dynamics: Project Documentation and Presentation, Evaluation and Awarding Marks

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Module code M BDSD	Big Data & Small Data
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Carolien Kattenbelt
Professional Task	Collect dataset, interpret features of dataset and create prediction model
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Module Systems Modelling
General Description	The module covers the following tasks: ¶ Collect a relevant dataset ¶ Interpret the features of the dataset ¶ Offline create prediction model using either system identification techniques or supervised machine learni ¶ Evaluate the model
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Data Collection and machine learning (7,5 EC) Capita Selecta in Machine learning (2.5 EC) Project Big Data & Small Data (5 EC)

Unit of Study (UoS) M BDSDT	Data Collection and Machine Learning
General Information	
Name of unit of study	Data Collection and Machine Learning
Code for unit of study	M BDSDT
Teaching Term	Semester 1 / Semester 2
Credits/study load	7,5 EC / 210 hours
Study hours (contact hours)	80 contact hours
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Analyze a dataset and create a prediction model
(Professional) products	black box model
General description	Thestudents have to carry out assignments in which they lea how to clean up a dataset so that it is directly usable for prediction purposes. Furthermore students will analyze the data within the dataset and find e.g. correlation among variables. The studentalso learns how to make prediction models using large number of supervised machine learning algorithms. Th student can apply these models to datasets and knows the advantages and disadvantages of the different methods.
Compulsory literature	
Recommended literature	-
Software and other materials	Matlab Simulink
Relationship	Units of study Big Data & Small Data
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Working on applied assignments using a simulation environment Work forms: Lectures, flipped classroom, assignments
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Knowledge and understanding (Analyzing and defining problems, design and testing algorithms) - Applying knowledge and understanding (design) - Making judgements (testing) The student formulates a question on what they want to achieve with the dataset (BDSDHTE1)

	The student judges if the dataset contains enough data and the data contains the right features to answer the formulated question. He or she knows how to deal with missing or erroneous data and can scale that dataset if necessary and select test and validation sets (BDSD-HTE1) The student interprets the features of the dataset. He or she is able to use clustering techniques like k-means and look for correlation between data and use PCA (BDSD-HTE1) The student can apply supervised machine learning techniques for predictive analysis like linear regression, logistic regression and neural networks and motivate why they chose that particular technique(BDSD-HTE1) The student can evaluate and compare models by picking a relevant metric like e.g. R^2 (BDSD-HTE1) The student can apply supervised machine learning techniqu for predictive analysis like techniques from System Identification (BDSD-HTE2)		
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form (next page)		
Information for each exam and modular exam			
Examinations	Exam code	M_BDSD_T_HTE1	M_BDSD_T_HTE2
		Week 1.9 and 3.9	Week 2.9 and 4.9
	First examiner	Carolien Stroomer / Marijn Jongerden / Hatim Mala / Saskia Monsma / Dixon Devasia	
	Exam method	Home taken exam	Home taken exam
	Permitted resources	Everything, but all results must be th ă ú dz Ř Ŝ y˝ ú Ω ă ž ø y˝ ø ž N	
	Number of examiners	1	1
	Assessment	Mark	Mark
	Pass mark	55	
	Minimal result	45	45
	Weight	3	1
	Reassessment	1	1
	Compensation	yes	
	Review	Evaluation form in week 2.4 and 4.4	Evaluation form in week 3.4 and 4.12
Other information			
Required classroom	Regular classroom		

Data Collection and Machine Learning: Evaluation and Awarding Marks

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Unit of Study (UoS) M BDSD CS	Capita Selecta in Machine Learning
General Information	
Name of unit of study	Capita Selecta in Machine Learning
Code for unit of study	M BDSD ASI
Teaching Term	Semester 1 / semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	16 contact hours
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Analyze previous work on application of Machine Learning algorithms on real world problems
(Professional) products	Presentation of literature review
General description	Critical review of literature on machine learning in a certain application area
Compulsory literature	
Recommended literature	-
Software and other materials	Matlab, Simulink, scientific papers
Relationship	Units of study Big Data & Small Data
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, case studies Work forms: Lectures, , reporting/presentations
Examinations	
Final Qualifications	C5 Conducting Research
Assessment dimensions / Learning outcomes	Dimensions of assessment: - knowledge and understanding (conducting research) - Applying knowledge and understanding - Making judgements (conducting research) The student can critically review work of others on machine learning applications and suggest how to improve the work.

Assessment criteria	The student will be assessed on the criteria mentioned on t evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M BDSD CS
		Week2.9 / 4.9
	First examiner	Marijn Jongerden/ Hatim Mala/ Dixon Devasia
	Exam method	Home taken exam
	Permitted resources	Everything, but all results Ydz ă ű ō Ŝ ű Ƙ Ŝ work
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Evaluation form in week 3.4 and 4.12
Other information		
Required classroom	Regular classroom	

Capita Selecta in machine learning

Evaluation and Awarding Marks

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Unit of Study (UoS) M BDSD MP	Big data Minor Project
General Information	
Name of unit of study	Big Data Minor Project
Code for unit of study	M BDSD MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Create a predictive model
(Professional) products	A predictive model, Project documentation, Presentation
General description	The Project serves to challenge the students to apply their knowledge and skills on a real life problem, in correspondence with a subset of the final qualifications. The project covers the following topics: - Analyzing data of a real life problem - Developing a prediction model for this problem. The problem analysis will result in a problem solution to be translated in such terms that conclusions can be drawn based the extent the problem has been solved and objectives fulfilled
Compulsory literature	¶ Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 ¶ Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	Matlab, Simulink, Python, SPSS
Relationship	Units of study Big Data & Small Data
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment Analyzing data and creation of a predictive model using techniques from system identification and/or machine learning.
Examinations	

Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and defining problems, design, testing, conducting research) - Making judgements (analyzing and defining problems, design, testing, conducting research) - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approach. The student plans effectively. Thestudent carries out a project based on a real-life problem in which model development and analysis as well as experiment validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings in a structured and convincing way. The student is able to systematically search for information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms.The content has been reviewed by peers and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student can make a motivated choice of which machine learningtechniques he/she uses. The student can evaluate and compare models by picking a relevant metric like e.g. R^2.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student:

	1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on conten and collaboration. If the outcome of the first peer review is negative for the individual student, the student still h the opportunity to improve. If the result is negative aga during the second peer review, the student will not receive a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M BDSD MP SC	M BDSD MP DP
		Week 2.9/2.10 and	2.10/4.10
	First examiner	Carolien Kattenbelt / Marijn Jongerden / Dixon Devasia	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be ű Ǩ Ŝ ă ű dz Ř Ŝ y˝ ű Ω ă ž	
	Number of examiners	2	2
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	1, week 4.11/4.12	
	Compensation	No	
	Review	Feedback after presentation / evaluation form in week 3.4 and 4.12	
Other information			
Required classroom	Regular classroom		

Big Data & Small Data: Project Documentation and Presentation: Evaluation and Awarding Marks

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Module M DS	Distributed Systems
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Aart-Jan de Graaf
Professional Task	Design, implement, verify, and test distributed embedded control systems
Professional Products	Report Design Presentation Article
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	¶ A basic level of programming experience, preferably in th C programming language ¶ Systems Modeling
General Description	The module provides an understanding of the principles on which distributed embedded systems are based, such as architectural design, protocols, algorithms, fault handling, an maintenance. The key principle is real-time behavior and how this affects quality requirements (resource limited reasoning). These principles are applied during a minor project that follo the values and principles of agile software development and uses the C programming language.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Distributed Systems Theory (7.5 EC) Distributed Systems Capita Selecta (2.5 EC) Distributed Systems Minor project (5.0 EC)

Unit of Study (UoS) M DS T	Distributed Systems Theory
General Information	
Name of unit of study	Distributed Systems Theory
Code for unit of study	M DS T
Teaching Term	Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours + 3 contact hours exam
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Design and test distributed embedded control systems
(Professional) products	Architectural design
General description	The course provides the design concepts and principles of distributed embedded systems, such as architectural design real-time aspects, protocols, fault handling, and maintenance.
Compulsory literature	¶ Kopetz, H. (2011). *Real-time systems: design principles for distributed embedded applications*. Springer Science & Business Media.
Recommended literature	¶ Pfeiffer, O., Ayre, A., & Keydel, C. (2016). *Embedded networking with CAN and CANopen*. Copperhill Media. ¶ Tanenbaum, A. S., & Van Steen, M. (2007). *Distributed systems: principles and paradigms*. Prentice-Hall. https://www.distributed-systems.net/index.php/books/distributed-systems-3rd-edition-2017/
Required software	Matlab, Simulink
Relationship	Units of study Distributed Systems
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, case-studies, working on assignments and exercis Work forms: Lectures, lab exercises
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing
Assessment dimensions / learning outcomes	Dimensions of assessment: Knowledge and understanding (Analyzing and defining problems) Applying knowledge and understanding (Design and Testing Learning outcomes: ¶ The student is able to relate an abstract design model to digital implementation of a simple control application

	¶ The student knows how design decisions affect efficienc scalability, and maintenance of distributed systems. ¶ The student knows time related aspects of real-time *behavior*, such as order, measurement, synchronization, and scheduling. ¶ The student knows the characteristics of real-time *communication* and how to use a time-triggered protocol. ¶ The student designs a fault tolerant distributed system. ¶ The student interprets electrical and protocol specifications, such as CAN or FlexRay, and relates this the design.		
Assessment criteria	The student will be assessed on answering the questions (W ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc. The student will be assessed (HTE) on the criteria mention on the evaluation form.		
Information for each exam and modular exam			
Examinations	Exam code	M DS HTE	M DS OE
		Week 3.9	Week 4.9
	First examiner	Aart-Jan de Graaf, Dixon Devasia, Nikhil Muthakana	
	Exam method	Home taken exam	Written exam
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă	Simple scientific calculator
	Number of examiners	1	1
	Assessment	Mark	Mark
	Pass mark	55	
	Minimal result	45	45
	Weight	1	1
	Reassessment	August 15	August 18
	Compensation	yes	
	Review	Evaluation form in week 4.4	Week 4.12
Other information			
Required classroom	Regular classroom		

Theory classes of Distributed Systems
Evaluation and Awarding Marks
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Unit of Study (UoS) M DS CS	Distributed Systems Capita Selecta
General Information	
Name of unit of study	Distributed Systems Capita Selecta
Code for unit of study	M DS CS
Teaching Term	Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	32 contact hours
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Explore novel developments of distributed systems and their use in contemporary applications.
(Professional) products	Literature study report in the form of an article to inform peer students.
General description	The course explores the use of distributed systems in contemporary applications, such as the Internet of Things, M2M solutions, the cyber physical world, and systems-of-systems. This exploration is achieved by means of a literature study, with literature from papers, articles, blogs and/or other relevant resources. The results are presented in a literature study report.
Compulsory literature	To be decided during class, depending on the subject.
Recommended literature	To be decided during class, depending on the subject.
Software and other materials	-
Relationship	Units of study Distributed Systems
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, case studies Work forms: Lectures, interactive simulation exercises, assignments, reporting
Examinations	
Final Qualifications	C5 Conducting research C6 Communication and collaboration
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (Conducting Research) - Making judgements (conducting research) - Communication (conducting research)

	¶ The student is aware of distributed systems in one or more contemporary applications. ¶ The student finds and selects relevant scientific resources for a selected topic. ¶ The student determines the validity of a referenced resources. ¶ The student writes a literature study report with a trailer, main text, a conclusion, a discussion and references. ¶ The student specifies references according a literacy standard.	
Assessment criteria	The student will be assessed on the criteria (questions) on the evaluation form.	
Information for each exam and modular exam		
Examinations	Exam code	M DS CS
		Week 4.6
	First examiner	Aart-Jan de Graaf, Dixon Devasia, Nikhil Muthakana
	Exam method	Home taken exam: Article
	Permitted resources	Everything, but all results must be ű K Ŝ ă ű dz Ř Ŝ y˝ ű Ω ă ž
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	Week 4.11 / 4.12
	Compensation	No
	Review	Evaluation form in week 4.10
Other information		
Required classroom	Regular classroom	

Capita Selecta, Evaluation and Awarding Marks

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Unit of Study (UoS) M DS MP	Distributed Systems Minor Project
General Information	
Name of unit of study	Distributed Systems Minor Project
Code for unit of study	M DS MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Design, implement, verify and test distributed embedded syster
(Professional) products	Documentation / presentation / defense Source code
General description	In this course students will design, implement, verify, and test t principles of distributed systems in a project. The project appro follows the values and principles of agile software development and uses the C programming language.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordho Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591 Kopetz, H. (2011). *Real-time systems: design principles for distributed embedded applications*. Springer Science & Business Media.
Recommended literature	Pfeiffer, O., Ayre, A., & Keydel, C. (2010). *Embedded networking with CAN and CANopen*. Copperhill Media.
Software and other materials	Matlab, simulink, C
Relationship	Units of study Distributed Systems
Compulsory participation	yes
Activities and instructional formats	Two students working together in a group, progress meetings with supervisor
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development

Assessment dimensions / Learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and defining problems, design, testing, conducting research principles of distributed systems in C) - Making judgements (analyzing and defining problems, design, testing, conducting research of principles of distributed systems)) - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes (general): The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings in a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider publi in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. Learning outcomes (specific): The student applies the values and principles of agile software development. The student designs a distributed embedded system for a given problem description. The student justifies the real-time aspects of the designed distributed embedded system. The student implements the designed distributed embedded system by using the C programing language and selected hard platforms, tests the design, and demonstrates the realization. The student shows by means of test reports the fault tolerance capabilities of the implemented distributed system. The student reports realistically about efficiency, scalability, and maintenance of the implemented distributed system. The student uses a protocol standard, such as CANopen or Fle for transferring data between embedded systems.

Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 4. A group mark will be defined by the examiners. 5. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. If the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not receive a pass and therefore no final grade. 6. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.			
Information for each exam and modular exam				
Examinations	Exam code	M DSMP PP	M DS MP GC	M DS MP DD
		Week 3.9	Week 4.9/4.10	
	First examiner	Aart-Jan de Graaf, Dixon Devasia, Nikhil Muthakana		
	Exam method	Project Plan	Group Contri-bution	Doc. and Demon-stration
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž NJ ˚		
	Number of examiners	1	2	
	Assessment	Pass	Pass	Mark
	Pass mark	V	Pass	55
	Minimal result	V	Pass	55
	Weight	0	0	1
	Reassessment	1 (4.2)	1, week 4.11/4.12	
	Compensation	no	No	
	Review	Evaluation form week 4.4	Feedback after presentation / evaluation form in week 4.12	
Other information				
Required classroom	Control systems lab			

DS:Project Documentation and Demonstration: Evaluation and Awarding Marks

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Module M EHFP	Electric, hybrid & fuel cell powertrains
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Ad Oomen
Professional Task	Understand, analyze and contribute to innovations in electric hybrid and fuel cell powertrains
Professional Products	Project plan (minor project) Report (minor project) Presentation (minor project) Model (model assignment) Report (model assignment) Presentation (Capita Selecta)
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Applied Control Systems Modelling
General Description	In this module the student will gain knowledge on analyzing innovative powertrains concerning performance, energy efficien environmental sustainability, costs or any other relevant aspect Theory In the theory part the student will gain knowledge of the physics required for analyzing powertrains. The working principals of the powertrain, its subsystems and components will be studied. The student will model powertrains using grey box models. Attention will be paid to relevant control aspects of powertrains regarding optimization of energy efficiency in hybrid systems. The student will learn the physical implications of the concept choices made Project The student will implement the theory learned in a modelling project having the appropriate level of detail and showing the powertrain layout, relations between components and powertrain output. Validation will be done using experimental data.
Final Qualifications	C1 Analysing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7Professional development
Units of study	This module consists of the following 3 units: Electric hybrid & fuel cell powertrains Theory (7.5 EC) Electric hybrid & fuel cell powertrains Capita Selecta (2.5 EC) Electric hybrid & fuel cell powertrains Minor Project (5 EC)

Unit of Study (UoS) M EHFP T	Electric hybrid & fuel cell powertrains: Theory
General Information	
Name of unit of study	Electric hybrid & fuel cell powertrains: Theory
Code for unit of study	M EHFP T
Teaching Term	Semester 1 / Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours + 6 contact hours exam week (2 written exams)
Entry requirements	Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Concept design and analysis of innovative hybrid powertrains
(Professional) products	Not applicable
General description	The course covers the following topics: ¶ The vehicle powertrain as a system ¶ Main powertrain functions ¶ Powertrain subsystems and components ¶ Powertrain modelling and model validation ¶ Optimization of energy efficiency ¶ Analysis on environmental sustainability ¶ Control aspects of powertrains
Compulsory literature	¶ Mehrdad Ehsani, Yimin Gao, Ali Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, Third edition, ISBN 9781138330498 ¶ Lecturing materials and handouts on OnderwijsOnline
Recommended literature	¶ Lino Guzzella, Antonio Sciarretta, *Vehicle Propulsion systems*, Third edition, Print ISBN 9783642359125 and online ISBN 9783642359132
Required software Required hardware	MATLAB/Simulink, AMESim Laptop with sufficient internal memory
Relationship	M EHFP CS and M EHFP MP Module: Systems Modelling and Applied Control
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Lectures, Self-study, Working on assignments
Examinations	
Final Qualifications	C1 Analyzing and defining problems
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems) The student analyzes advanced and innovative configurations of complete vehicle powertrain and is able to make conceptual design choices concerning it.

	The student uses relevant white box or grey box modelling methods to determine the physical model of a vehicle powertrain. The student understands relevant control aspects of powertrains regarding optimization of energy efficiency. (WE1 and WE2) The student is able to analyze a problem in the field of automotive powertrains by using state of the art Computer Aided Engineering (CAE) tools. The student is able to create an optimized solution for an automotive powertrain. (HTE)
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc. M EHFP WE1 and WE2: The WarmUp Test result given by the lecturer during the lecturing of the theory determines 20% of the score of the written (re) exams. ***For re-exams the WarmUp Test result of the previous attempt n***

Information for each exam and modular exam				
Examinations	Exam code	M EHFP HTE	M EHFP WE1	M EHFP WE2
		Week 2.7 / 4.7	Week 1.9 / 3.9	Week 2.9 / 4.9
	First examiner	Ad Oomen / Bram Veenhuizen / Aishwarya Aswal		
	Exam method	Assignment CAE	Written exam	Written exam
	Permitted resources	CAE	All/no laptop	All/no laptop
	Number of examiners	1	1	1
	Assessment	Mark	Mark	Mark
	Pass mark	55		
	Minimal result	45	45	45
	Weight	1	2	2
	Reassessment	1	1	1
	Compensation	yes		
	Review	Evaluation form week 4.12/3.4	Review Week 4.4/ 2.4	Review week 4.12/ 3.4
Other information				
Required classroom	Regular classroom			

Electric hybrid & fuel cell powertrains- HTE

Evaluation and Awarding Marks
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Unit of Study (UoS) M EHFD CS	Electric hybrid & fuel cell powertrains Capita Selecta
General Information	
Name of unit of study	Electric hybrid & fuel cell drive lines Capita Selecta
Code for unit of study	M EHFP CS
Teaching Term	Semester 1 / Semester 2
Credits/study load	2,5 EC / 56 hours
Study hours (contact hours)	16 contact hours
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Understand and analyze the innovative hybrid powertrains. Study and interpret scientific literature.
(Professional) products	Presentation and oral defense.
General description	Make a thorough analysis of a peer reviewed scientific paper(s) on innovations in drive lines.
Compulsory literature	-
Recommended literature	-
Software and other materials	-
Relationship	M EHFP T and M EHFP MP Module: Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Self-study, Instruction on demand, reporting, presenting
Examinations	
Final Qualifications	C5 Conducting Research
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Making judgements (conducting research) - Communication (conducting research)

	The student is able to analyze a scientific paper on innovations in powertrains and to identify its strengths and potential shortcomings. The student is able to formulate a proposal for extending or enhancing the analyzed scientific research. The student understands the role of powertrain innovations and developments in the perspective of the modern, evolving societ	
Assessment criteria	The student will be assessed on the criteria (questions) mentio on the evaluation form.	
Information for each exam and modular exam		
Examinations	Exam code	M EHFPCS
		Week 2.1 / 4.1
	First examiner	Ad Oomen / Bram Veenhuizen / Aishwarya Aswal
	Exam method	Presentation and defense
	Permitted resources	Everything, but all results must be ű K Ŝ ă ű dz Ř Ŝ y˝ ű Ω ă 2
	Number of examiners	2
	Assessment	Mark
	Pass-mark	55
	Minimal result	55
	Weight	1
	Reassessment	4.11 / 4.12
	Compensation	No
	Review	Feedback after presentation Evaluation form week 2.8 / 4.8
Other information		
Required classroom	Regular classroom	

Electric hybrid & fuel cell powertrains- Capita Selecta

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Unit of Study (UoS) M EHFP MP	Electric hybrid & fuel cell powertrains Minor Project
General Information	
Name of unit of study	Electric hybrid & fuel cell drive lines Minor Project
Code for unit of study	M EHFP MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	20 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Conducting literature research Modelling and validation
(Professional) products	Project plan Model Report Presentation
General description	The students have to carry out an assignment of which model development and analysis as well as experimental validation ar essential parts. The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications and t course discusses the skills needed to perform a research proje and includes performing a literature study.
Compulsory literature	-
Recommended literature	Project Management, A Practical Approach, Roel Grit, Noordho Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Software and other materials	MATLAB/Simulink, AMEsim
Relationship	M EHFP T and M EHFP CS Units of study Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Assignment
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration

	C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment - Applying knowledge and understanding (analyzing and defining problems, design, conducting research) - Making judgements (analyzing and defining problems, Design, Conducting Research - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimenta validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider pub in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student is able to analyze a real life problem concerning powertrains. The student is able to create a model for a powertrain problem and to perform a relevant analysis. The student is able to validate modelling results against the real life situation and problem definition. The student is able to formulate a proposal for improvement of powertrain problem and is able to make an assessment of its viability taking into account energy efficiency and environmental sustainability using proper techniques like prototyping, modelling or analysis.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form.

	To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not receive a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M EHFP MPGC	M EHFP MPDP
		Week 2.9/2.10 and 4.9/4.10	
	First examiner	Ad Oomen / Bram Veenhuizen / Aishwarya Aswal	
	Exam method		Documentation / presentation
	Permitted resources	Everything, but all results must be the ă ú dz Ř Ŝ ŷ ŵ ŏ ă	
	Number of examiners	2	2
	Assessment	pass	Mark
	Pass mark	pass	55
	Minimal result	pass	55
	Weight	0	1
	Reassessment	Week 4.11 / 4.12	
	Compensation	No	
	Review	Feedback after presentation / evaluation form in week 4.12	
Other information			
Required classroom	Regular class room		

Electric hybrid & fuel cell powertrains- Minor Project: Project Documentation and Presentation
Evaluation and Awarding Marks
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Module M HT2	HydrogenTechnology
Degree program	Master Engineering Systems
Target Group	Elective module (Automotive Systems, Sustainable Energy)
Coordinating lecturer	Bram Veenhuizen
Professional Task	Understand, analyze and contribute to technical and societal aspects of hydrogen technology and their interactions.
Professional Products	Project plan (project) Report (project and capita selecta) Presentation (progress and final) Test plan and test report (project) if appropriate
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Module Systems Modelling Module Applied Control
General Description	The Module H2 focuses on the role hydrogen can play in the energy transition. We will mainly focus on decentralized system ranging from electrolysers and fuel cell stacks to internal combustion engines running on hydrogen. System design, integration and control will be important aspects, but also safety and other standards will be addressed. A separate course on s working with hydrogen is part of the module. Applications will range from static sustainable energy storage to mobile applications in cars, trucks and inland shipping. All main design aspects will covered, mainly by using model based design techniques. The student will get familiar with analyzing and performing technical and economical calculations on energy systems. Next to that the student will learn how to apply and understand relevant state-of-the art scientific literature. The students will wo in a project to apply the knowledge, application skills and insigh acquired during the lectures. The student will get the opportunity to perform lab experiments.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Hydrogen Technology Theory (7.5 EC) Hydrogen Technology Capita Selecta (2.5 EC) Hydrogen Technology Project (5 EC)

Unit of Study (UoS) M HT2T	Hydrogen Technology theory
General Information	
Name of unit of study	Hydrogen Technology Theory
Code for unit of study	M HT2 T
Teaching Term	Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours + 6 contact hours exam (written exam WE 1 / 2)
Entry requirements	Systems Modelling / Applied Control
Objectives and instructional formats	
Professional task	Concept design and analysis of engines and fuels
(Professional) products	Concept level design engineer for decentralized hydrogen base systems. Test engineer for hydrogen based systems Analyze and disseminate Sustainable Energy Technology & Ene systems modelling and understand energy and environmental policy and regulation implications.
General description	The course Hydrogen technology covers the following topics: ¶ Role of hydrogen in the energy transition o { ǘ ƻ NJ l· ∃ Ŝ ó a I Σ [I н Σ [h I ¶ Applications of hydrogen ¶ Hydrogen systems o (engines, combustion, FC, DCDC, heaters, etc.) o Modeling o Energy management o sizing ¶ Safety course on working with hydrogen ¶ Rules and regulations o Automotive o Stationair ¶ Hydrogen sources o Electrolysis o Gas reforming o Biological sources ¶ Aspects of Process technology ¶ Electrochemistry and thermodynamics o Bindingsenthalpie o Catalyse o Elektroliet ¶ Heat production and use ¶ System durability

Compulsory literature	Fuel Cell Handbook / 7th Edition 2004 Lecturing materials and handouts on Onderwijs Online
Recommended literature	Not applicable
Required software	Matlab Simulink / GT Power
Relationship	M HT2 CS and M HT2 MP
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, discussion of literature, assignments and exercises.
Examinations	
Final Qualifications	C1 Analyzing and defining problems
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems), analysis, fundamentals and applications Learning outcomes: The student ¶ has developed knowledge and understanding of the fundamentals of hydrogen, its practical applications and role in the energy transition. ¶ Is able design on a concept level, able to analyze and suggest improvements on system level for hydrogen ba energy systems ¶ Can apply rules and regulations for system design ¶ Has practical knowledge on how to work with hydrogen according to safety regulations
Assessment criteria	The student will be assessed on answering the questions: ¶ Clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ Without irrelevant additional information ¶ Using correct equations and models for the situation There is a separate modelling assignment given by the lecturer during the lecturing of the modelling subject within the course. The assignment is examined by the examiner familiar with the modelling subject.
Information for each exam and modular exam	

Examinations	Exam code	M HT2 T1	M HT2 T2	M HT2 HTE
		Week 3.9	Week 4.9	Week 4.6
	First examiner	Bram Veenhuizen, Menno Merts, Leo Polak, Stefan Sterkenburg, Rik Catau		
	Exam method	Written exam	Written exam	Home taken exam
	Permitted resources			
	Number of examiners	1	1	1
	Assessment	mark	Mark	mark
	Pass mark	55		
	Minimal result	45	45	55
	Weight	1	1	1
	Reassessment	1	1	1
	Compensation	Yes		
	Review	Review Week 4.4	Review week 4.12	Evaluation form week 4.12
Other information				
Required classroom	Regular classroom, laboratory and computer class room			

Unit of Study (UoS) M HT2CS	Hydrogen Technology Capita Selecta
General Information	
Name of unit of study	Hydrogen Technology Capita Selecta
Code for unit of study	M HT2CS
Teaching Term	Semester 2
Credits/study load	2.5 EC / 56 hours
Study hours (contact hours)	32 contact hours and 1 contact hour presentation
Entry requirements	Systems Modelling & Applied Control
Objectives and instructional formats	
Professional task	Understand and analyze the innovations in hydrogen Technology
(Professional) products	Presentation on the subject
General description	Relevant literature is provided and papers are discussed in a journal club.
Compulsory literature	Handouts and papers
Recommended literature	-
Software and other materials	-
Relationship	M HT2 T and M HT2 MP
Compulsory participation	Yes
Activities and instructional formats	Self-study, discussion of literature. Work Forms: Lectures, Colloquia
Examinations	
Final Qualifications	C5 Conducting Research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Making judgements (conducting research) - Communication (conducting research) - Learning skills (conducting research) Learning outcomes: The student is able to understand scientific literature and presents and discusses the contents with fellow students while providing a relevant context.

Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form.	
Information for each exam and modular exam		
Examinations	Exam code	M HT2CS
		Week3.9
	First examiner	Bram Veenhuizen
	Exam method	Presentation and defense
	Permitted resources	Everything, but all results must ō Ŝ ű Ƙ Ŝ ă ű dz Ř Ŝ y ̋ ű
	Number of examiners	2
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Feedback after presentation Evaluation form week 4.4
Other information		
Required classroom	Regular classroom	

Hydrogen Technology Capita Selecta

Evaluation and Awarding Marks

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Unit of Study (UoS) M HT2MP	Hydrogen Technology Minor Project
General Information	
Name of unit of study	Hydrogen Technology Minor Project
Code for unit of study	M HT2MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling/ Applied Control
Objectives and instructional formats	
Professional task	The professional task consists of: - Design a hydrogen based Energy system, make a mod and simulate output - Perform tests on a hydrogen based energy system - Determine economic and social, legal viability and safet of hydrogen based energy system(s)
(Professional) products	Project plan, Report and Presentation/Defence
General description	The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications. The project covers the following topics: ¶ The problem to be solved requires an understanding an active analysis of distinctive disciplines. ¶ The project will always include the step from a real-life problem to a more abstract representation of the problem. Required results are described under the professional product section. The problem analysis will result in a problem solution to be translated in such terms that conclusions can be drawn based on the extent the problem has been solved and objectives fulfilled.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordhof Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	Matlab simulink, GT Power
Relationship	M HT2 T and M HT2 CS
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment

Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment - Applying knowledge and understanding (Analyzing and defining problems, Design, Conducting Research) - Making judgements (Analyzing and defining problems, Design, Conducting Research - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes (general): The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimenta validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search for information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider pub in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. Learning outcomes (specific): The student can critique on and analysis of problems in the fiel energy system design, system simulation and testing, feasibility study. The student evaluates energy models and make informed decisions based on scenario information.

	The student creates a proposal for improvement on an analyze and evaluated energy system or plan a new design for an ener system; taking into account use of renewable resources, energy efficiency and environmental sustainability.		
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 4. A group mark will be defined by the examiners. 5. Peer review each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still ha the opportunity to improve. If the result is negative agair during the second peer review, the student will not rece a pass and therefore no final grade. 6. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review Students should be aware of their own functioning within the project group, so should arrange peer feedback within their pro group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M HT2MPGC	M HT2 MP DP
		Week 4.10	
	First examiner	Bram Veenhuizen	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be th ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž Ń	
	Number of examiners	2	
	Assessment	Pass	Mark
	Pass mark	V	55
	Minimal result	V	66
	Weight	0	1
	Reassessment	1 (week 4.11 / 4.12)	
	Compensation	no	
	Review	Feedback after presentation / evaluation form week 4.12	
Other information			
Required classroom	Regular class room		

Hydrogen Technology Project Documentation and Presentation
Evaluation and Awarding Marks
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Module M PCD	Process Development
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Stef Tiggeloven
Professional Task	(Re)design and improve manufacturing processes
Professional Products	(Re)design and improvement of manufacturing processes
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Simultaneously to the Module Systems Modelling or after taki classes Systems Modelling
General Description	In this module students will learn and apply lean principles an methods for the design, operational control and improvement manufacturing processes. The focus of the module is on the design and planning & control of manufacturing system. The u of new technology to support Lean Manufacturing plays an important role in the module: as well new manufacturing as Industry 4.0 technologies. Students will gain the knowledge and ability to apply important Lean principles, methods and techniques, in combination new technologies, to (re)design manufacturing processes. Discrete simulation, supporting the modelling and analysis of a system is part of the course as well as the quality control methods. Next to this, students will gain knowledge on various top-down and bottom-up Continuous Improvement methods and tools (routines) to be applied in manufacturing companies. Students will apply this knowledge in an improvement proje in industry related projects where they use the (PDCA) A3 methodology and reporting method. This methodology consist of context analysis, describing the current state, formulating objectives, future state design, implementation planning and follow-up design. Students will also learn to search for relevant scientific literature which supports their improvement project. They will learn to link this literature to practice
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Process development (Operations Design / Operations Planning and Control (4 EC / 3.5 EC)) Capita Selecta (2.5 EC) and the minor project (5 EC)

Unit of Study (UoS) M PCD OD	Process Development Operations Design
General Information	
Name of unit of study	Process Development Operations Design
Code for unit of study	M PCD OD
Teaching Term	Term 1/ term 3
Credits/study load	4 EC / 112 hours
Study hours (contact hours)	32 contact hours + 3 contact hours exam
Entry requirements	After taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Application of Lean and Operations Management methods in design of manufacturing processes
(Professional) products	Not applicable
General description	The course focuses on the design of manufacturing processes contains the following topics: ¶ Lean Introduction : Customer value and key lean principle ¶ Value Stream Analysis and Design ¶ Methods of Root Cause Analysis ¶ Key Factory Physic laws Little law, Utilization law, bottleneck principle ¶ Manufacturing Strategy (Product Profiling, Performance Importance Matrix, Policy Deployment) ¶ Factory Flow Analysis, Layout Types, Clustering Methods Multi criteria decision making ¶ Process and LEAN4.0 Technologies
Compulsory literature	¶ Operations Management, Nigel Slack, Alistair Brandon-Jones and Robert Johnston, 9e editie (2019). Another Textbook o Operations Management, which also focuses on master le is fine. In the module, references will be made to this particular text book. ¶ ¢ Ƙ Ŝ [Ŝ ł ƴ { ƛ Ȅ { ƛ Ǝ Ƴ ł t ƻ Ŏ ʅ Ŝ ǘ David Rowlands, Mark Price en John Maxey. ISBN 978-0-07-1441193 ¶ Learning to See, Value Stream Mapping to Create Value an eliminate Muda, van Mike Rother and John Shook, ISBN/E 9780966784305 (available on the internet) ¶ Reader Applied Manufacturing Management: papers + she used in the classes.
Recommended literature	-
Required software	-
Relationship	Units of study Process Development

Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Self-study, Working on assignments and exercises Work Forms: Lectures and teamwork	
Examinations		
Final Qualifications	C1 Analyzing and defining problems with respect to process design C2 Design of a manufacturing process/system	
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems) ¶ Applying Knowledge and understanding: Application of lea and operations management methods The student is able to analyze and design (manufacturing) processes.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels etc.	
Information for each exam and modular exam		
Examinations	Exam code	M PCD OD WE
		Week 1.9 / 3.9
	First examiner	Stef Tiggelove, Jannes Slomp
	Exam method	Written exam
	Permitted resources	-
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Week 2.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M PCD OPC	Process Development Operations Planning and Control
General Information	
Name of unit of study	Process Development Operations Planning and Control
Code for unit of study	M PCD OPC
Teaching Term	Term 2/ term 4
Credits/study load	3.5 EC / 98 hours
Study hours (contact hours)	32 contact hours and 3 hours written exam
Entry requirements	After taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Application of Lean and Operations Management methods i the Design of a Planning and Control System for manufactu processes
(Professional) products	Not applicable
General description	The course focuses on the design of planning and control systems for manufacturing processes and contains the following topics: ¶ Topic related to methods of planning & control (medium theories) Inventory Control ¶ MRP ¶ JIT ς planning & control methods ¶ Production Activity Control / Job Shop Control Topic which concern basic knowledge needed for developin planning & control systems for a particular situation (basic theories): ¶ Push / Pull control principles ¶ TQM and Quality Control (including statistics) ¶ Factory Physics ς Ø l· NJ ƛ l· ō ƛ f ƛ ű è Σ Y ƛ y Ǝ ¶ Discrete Simulation
Compulsory literature	¶ Operations Management, Nigel Slack, Alistair Bran-don Jones and Robert Johnston, 9e ed (2019), or another basic text book on Operations Management, which also focuses on master level educations. In the module, references will be made to this particular text book. ¶ ¢ K Ŝ [Ŝ l· y { ƛ È { ƛ Ǝ Y l· t ƨ Ŏ ļ Ŝ ú George, David Rowlands, Mark Price en John Maxey. ISB 978-0-07-144119-3 ¶ Reader Applied Manufacturing Management (papers + sheets used in the classes
Recommended literature	-
Software and other materials	-

Relationship	Units of study Process Development	
Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Self-study, Working on assignments Work Forms: Lectures and teamwork	
Examinations		
Final Qualifications	C1 Analyzing and defining problems with respect to process design C2Design of a planning and control system for a manufactur process	
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems) ¶ Applying Knowledge and understanding (Application of l and operations management methods for designing the planning and control for manufacturing processes) The student is able to design and to perform a planning and control system for manufacturing processes.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labe etc.	
Information for each exam and modular exam		
Examinations	Exam code	M PCD OPC WE
		Week 2.9/ 4.9
	First examiner	Stef Tiggelove, Jannes Slomp
	Exam method	Written exam
	Permitted resources	-
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Week 3.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M PCD CS	Process Development Capita Selecta
General Information	
Name of unit of study	Process Development Capita Selecta
Code for unit of study	M PCD CS
Teaching Term	Semester 1 / semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	32 contact hours
Entry requirements	After taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Linking scientific literature on technological developments to practical, operations management, topics.
(Professional) products	Documentation of the work in short reports and presentation
General description	In the Capita Selecta, students will study scientific literature link this to the elements in the courses Operations Design, Operations Planning & Control. Ideally one elements of their minor project. The topics concerns the impact of technology operations design and operations planning & control. Stude will learn to present their (new) insights in a paper, short reports as well as in presentations.
Compulsory literature	To be decided during class, depending on the subject.
Recommended literature	To be decided during class, depending on the subject.
Software and other materials	-
Relationship	Units of study Process Development
Compulsory participation	Attendance will be registered; at least joined 6 (out of 10) Capita Selecta presentations.
Activities and instructional formats	Study lectures, literature research, writing reports and presenting.
Examinations	
Final Qualifications	C5 Conducting research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Communication (Clear reports and presentations) The student is able to study scientific literature and link this t the elements in the field of Operations Design and Operation Planning & Control.

	The student is able to present their (new) insights in short reports as well as in presentations. The student is able to understand specialized applied scient knowledge in relevant topics concerning the impact of manufacturing and Industry 4.0 (Smart Industry) technologies on Operations Design and Planning & Control. Students are able to understand technology elements in the field of Process Improvement.	
Assessment criteria	The student will be assessed on the criteria mentioned on th evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M PCD CS
		Week 2.9/ 4.9 (finishing report)
	First examiner	Stef Tiggeloven, Jannes Slomp
	Exam method	Report & Presentation
	Permitted resources	Everything, but all results must be the ă ú dz Ř Ŝ y˝ ú Ω ă ž ø y˝ ø ž Ň
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result report	55
	Weight	1
	Reassessment	1 (week 4.11/4.12)
	Compensation	Yes
	Review	Feedback after presentation Evaluation Form: 3.4
Other information		
Required classroom	Regular classroom	

Process Development: Capita Selecta

Evaluation and Awarding Marks

	Mark	Motivation	Weight factor
Knowledge and understanding C5: Conducting Research Finding and understanding relevant and recent literature on the topic chosen. Able to explain the content.			1
Applying knowledge and understanding C5: Conducting Research Applying the concepts/theories/methods in the context of Lean Process Improvement, in a creative way			1
Making judgments C5: Conducting Research Demonstrates and discusses th applicability (internal and external validity) of the applications.			1
Communication C5: Conducting Research Presentation (oral and in a written report) of the research issue, methods and conclusion to specialist and non-specialist audiences.			1
Learning Skills C5: Conducting Research Study in a manner that may be largely self-directed or autonomous.			1
Mark total			

Date : Signature examiner 1 : Signature examiner 2 :

Unit of Study (UoS) M PCD MP	Process Development Minor Project
General Information	
Name of unit of study	Process Development Minor Project
Code for unit of study	M PCD MP
Teaching Term	Semester 1 / semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	(Re)Design and/or Improve of a Manufacturing System (design and planning & control + implementation issues), indicating the role of technology.
(Professional) products	Report (A3 plus clarifying appendices) on Manufacturing System design Presentation
General description	Students have to carry out an assignment on the (re)design or improvement of a product profiling in a company, including a related literature survey. Example problems: ¶ Improvement of an assembly line by using an Augmented Reality technology; ¶ Development of the ConWIP-Fifo-Takt system for a particular situation; ¶ Design of a U-shape cell for a particular case; ¶ Feedback and feedforward control mechanisms for improving the use of automated manufacturing techology; ¶ Development of Digital Twin control system
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	-
Relationship	Units of study Process Development
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Team work, intervision and Assignment
Examinations	

Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Assessment dimensions: Applying knowledge and understanding (Analyzing and defining problems, Design, Conducting Research) Making judgements (Analyzing and defining problems, Design, Conducting Research Communication (Managing work processes, Communication and Collaboration) Learning skills (Professional development) Learning outcomes: The student presents a clear justification of the project approach The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings in a structured and convincing way. The student is able to systematically search for information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms. The content has been reviewed by peers and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student is able to carry out an assignment on the design or improvement of a product profiling in a company, including a related literature survey.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content

	and collaboration. if the outcome of the first peer review is negative for the individual student, the student still ha the opportunity to improve. If the result is negative agair during the second peer review, the student will not receiv a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their pro group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M PCD MPGC	M PCD MP DP
		Week 2.9/2.10 and 4.9/4.10	
	First examiner	Stef Tiggeloven, Jannes Slomp, Gerlinde Oversluizen	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ ƴ ű Ω ă ƨ ǿ ƴ ǿ ƨ NJ ʅ	
	Number of examiners	2	
	Assessment	pass	Mark
	Pass mark	pass	55
	Minimal result	pass	55
	Weight	0	1
	Reassessment	1, week 4.11/4.12	
	Compensation	no	
	Review: Feedback after presentation Evaluation Form: week 3.4		
Other information			
Required classroom	Regular classroom		

PCD: Project Documentation and Presentation Evaluation and Awarding Marks

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Module M PDD	Product Development
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Jannes Slomp
Professional Task	(Re)design and improve products and/or development processes
Professional Products	Improved development processes and/or new or improved product designs
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	After taking classes Systems Modelling and Applied Control
General Description	In this module students will learn and apply lean principles and methods in the design and improvement of products. They will gain a broad and deep knowledge in several product design and development topics, such as opportunity identification, product planning, concept generation and selection, product architecture, DfX methods and important tools like Quality Function Deployment and Value Engineering. FFD and MFD strategy, operations design, project planning and control, opportunity identification and the role of technology in the improvement of products. They will learn what lean concepts and methods are that can be used in product development and design. They will apply this knowledge in an improvement project in the industry where they use the (PDCA) A3 methodology and reporting method.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Product Design (4 EC) Product Development Processes (3.5 EC) Capita Selecta (2.5 EC) Minor Project Product Development (5 EC)

Unit of Study (UoS) M PDD PD	Product Design
General Information	
Name ofunit of study	Product Design
Code for unit of study	M PDD PD
Teaching Term	Semester 2
Credits/study load	4 EC / 112 hours
Study hours (contact hours)	32 contact hours + 3 contact hours exam
Entry requirements	after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Application of key methods in the analysis and improvement o the architecture of a product
(Professional) products	Not applicable
General description	The course focuses on the analysis and design of the architecture of a current product design. The course contains following topics: ¶ Customer Value ¶ Product Architecture Mapping ¶ Quality Function Deployment ¶ Modularity Function Deployment ¶ Commonality and Platfoms ¶ Design for Six Sigma ¶ Requirement management ¶ DFX ¶ Value Analysis ¶ Portfolio analysis ¶ Life cycle analysis ¶ Circular designs
Compulsory literature	¶ Karl Ulrich, Steven Eppinger, and Maria C. Yang (2020). Product Design and Development 7th Edition, McGraw-Hill, ISBN-13: 978-1260043655; ISBN-10: 1260043657 ¶ Presentations and papers used in the classes, Reader
Recommended literature	-
Required software	-
Relationship	Units of study Product Development
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments and exercises Work Forms: Lectures

Examinations		
Final Qualifications	C1 Analyzing and defining problems with respect to the architecture of a product C2 Design (specification) of a product design improvement project	
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems) of product architecture mapping ¶ Applying Knowledge and understanding: Application of Product Architecture Mapping for the analysis and improvement of existing products The student is able to analyze product architectures and to specify improvement challenges	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of t literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (f example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M PdD PD WE
		Week 39
	First examiner	Jannes Slomp
	Exam method	Written exam
	Permitted resources	-
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	August
	Compensation	no
	Review	Week 4.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M PDD PDP	Product Development Processes
General Information	
Name of unit of study	Product Development Processes
Code for unit of study	M PDD PDP
Teaching Term	Semester 2
Credits/study load	3.5 EC / 98 hours
Study hours (contact hours)	32 contact hours and 3 hours written exam
Entry requirements	after taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Application of Product Design and Development principles a methods
(Professional) products	Not applicable
General description	The course focuses on the analysis and development of effi and effective processes for product design and developmen The course contains the following topics: ¶ Strategy building & deployment ¶ Technology Roadmapping ¶ Business performance management ¶ Project portfolio management ¶ Product Development Economics. ¶ Technology Roadmapping ¶ Project Management, ¶ Visual management (Obeya) ¶ Organizational models ¶ Development processes (e.g. stage gate, agile) ¶ Value proposition design ¶ Developing and identification of design opportunities ¶ Rapid learning cycles ¶ Set based development ¶ Concept generation, selection and testing ¶ Industrial Design ¶ Lean Startup ¶ Prototyping ¶ Robust Design ¶ Patents and Intellectual Property ¶ Knowledge management, trade-off curves ¶ Structured Problem Solving / A3 management
Compulsory literature	Readers, papers and presentations used in the classes
Recommended literature	-
Software and other materials	-
Relationship	Units of study Product Development

Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Self-study, Working on assignments Work Forms: Lectures	
Examinations		
Final Qualifications	C1 Analyzing and defining problems with respect to product design and development C2 Developing the process for efficient and effective product design and development	
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding (analyzing and defining problems) ¶ Applying Knowledge and understanding: Application of (lean) methods for designing processes for product design and development The student is able to analyze processes for product design development and to develop an appropriate process for the development of new products	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc.	
Information for each exam and modular exam		
Examinations	Exam code	M PDD PDPWE
		Week 49
	First examiner	Jannes Slomp
	Exam method	Written exam
	Permitted resources	-
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	August
	Compensation	no
	Review	Week 4.12
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M PDD CS	Product Development Capita Selecta
General Information	
Name of unit of study	Product Development Capita Selecta
Code for unit of study	M PDD CS
Teaching Term	Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	32 contact hours
Entry requirements	after taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Linking scientific literature on technological developments to processes and methods used in product development.
(Professional) products	Documentation of the work in short reports and presentation
General description	In the Capita Selecta, students will study scientific literature link this to the elements in the courses Product Architecture Mapping and Product Design and Development and/or elements of their minor project. The topics concerns the imp of technology on (lean) product development. Students will learn to present their (new) insights in short reports as well a in presentations.
Compulsory literature	To be decided during class, depending on the subject.
Recommended literature	To be decided during class, depending on the subject.
Software and other materials	-
Relationship	Units of study Product Development
Compulsory participation	Attendance will be registered; at least joined 6 (out of 10) Capita Selecta meetings
Activities and instructional formats	Study lectures, literature research, writing reports and presenting.
Examinations	
Final Qualifications	C5 Conducting research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Communication (Clear reports and presentations) The student is able to study scientific literature and link this t the elements in the field of the impact of smart technology

	(smart products) on the process and methods of product development. The student is able to present their (new) insights in short reports as well as in presentations.	
Assessment criteria	The student will be assessed on the criteria mentioned on th evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M PDD CS
		Week 49
	First examiner	Jannes Slomp
	Exam method	Report
	Permitted resources	Everything, but all results must be th ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž Ň
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1 (4.11 / 4.12)
	Compensation	Yes
	Review	Feedback after presentation Evaluation Form: week 4.12
Other information		
Required classroom	Regular classroom	

Product Development: Capita Selecta, Evaluation and Awarding Marks

	Mark	Motivation	Weight factor
Knowledge and understanding C5: Conducting Research ¶ A motivation of the topic chosen ¶ A research question ¶ Finding and understanding relevant and recent literature on the topic chosen. ¶ Able to explain the content.			1
Applying knowledge and understanding C5: Conducting Research Applying the concepts/theories/methods in the context of Lean Product Development, in a creative way.			1
Making judgments C5: Conducting Research Demonstrates and discusses the applicability (internal and external validity) of the applications.			1
Communication C5: Conducting Research Presentation (oral and in a written report) of the research issue, methods and conclusions to specialist and non-specialist audiences.			1
Learning Skills C5: Conducting Research Study in a manner that may be largely self-directed or autonomous.			1
Mark total			

Date :

Signature examiner 1 : Signature examiner 2 :

Unit of Study (UoS) M PDD MP	Product Development Minor Project
General Information	
Name of unit of study	Product Development Minor Project
Code for unit of study	M PDD MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	after taking classes Systems Modelling and Applied Control
Objectives and instructional formats	
Professional task	Design and/or Analysis & Improvement of a product or development process integrating technological knowledge.
(Professional) products	Report Presentation
General description	Students have to carry out an assignment on the (re)design or improvement of a product. Example projects: ¶ Development of a modular design for a heat recovery ventilation system ¶ Standardization of designs for vacuum chambers ¶ Optimization of agile processes for physical product development ¶ Development of products used in a circular economy
Compulsory literature	Papers, readers and presentations of the related topic, used the master module
Recommended literature	-
Software and other materials	-
Relationship	Units of study Product Development
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development

Assessment dimensions / learning outcomes	Assessment dimensions: Applying knowledge and understanding (Analyzing and definin problems, Design, Conducting Research) Making judgements (Analyzing and defining problems, Desig Conducting Research Communication (Managing work processes, Communication and Collaboration) Learning skills (Professional development) Learning outcomes: The student presents a clear justification of the project approach. The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis an validation techniques. The student structures the working process in the engineerin domain and is able to effectively communicate the core findi in a structured and convincing way. The student is able to systematically search for information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms. The content has been reviewed by peers and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student is able to systematically translate a lean engineering problem to a model at an abstract level, i.e. reducing it to its essentials in terms of model framework and problem requirements and to validate results against the real life situation and problem formulation. Through a careful root cause analysis, he is able to formulate the key design problem and a methodology to cope with these problems. He recognizes opportunities to integrate technical innovations in the improvements. He is able to develop alternative solution and to apply a solid selection method.
Assessment criteria	The student will be assessed on the criteria mentioned on th evaluation form. To determine the result of the minor project for each student 1. A group mark will be defined by the examiners.

	2. Peer review each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review the student will not receive a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.			
Information for each exam and modular exam				
Examinations	Exam code	M PDD MP PP	M PDD MP GC	M PDD MP DP
		Week 3.9	Week 4.10	
	First examiner	Jannes Slomp		
	Exam method	Project Plan	Group Contri-bution	Documen-tation / presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă 2 ø y˝ ø 2 NJ ļ		
	Number of examiners	1	2	
	Assessment	Pass	pass	Mark
	Pass mark	V	pass	55
	Minimal result	V	pass	55
	Weight	0	0	1
	Reassessment	1, week 4.2	1, (4.11/4.12)	
	Compensation	No		
	Review: Feedback after presentation Evaluation Form: week 4.12			
Other information				
Required classroom	Regular classroom			

Project Documentation and Presentation, Evaluation and Awarding Marks

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Module code M SES	Sustainable Energy Systems
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Rik Catau
Professional Task	Understand and design Sustainable Energy Systems
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
General Description	During the Module SES the student will learn about the broad range of renewable energy generation options that exist. The student will get familiar with analyzing and performing technical and economical calculations on energy systems. Also incorporated are storage applications which have a rapidly increasing role in such systems. The connection of renewables and storage to the electrical energy grid and discussion of their role within it is part of this module. Next to that the student will become familiar with the policy context because the increase in renewable energy applications is for most part politically driven. The student will also learn about environmental aspects as well interaction between actors which can be complex for energy systems. Next to that the student will learn how to apply and understand relevant state-of-the art scientific literature. The students will work in a project to apply the knowledge, application skills and insights acquired during the lectures.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Sustainable Energy Systems Theory (7.5 EC) Capita Selecta (2.5 EC) Energy Project (5 EC)

Unit of Study (UoS) M SES T	Sustainable Energy Systems Theory
General Information	
Name of unit of study	Sustainable Energy Systems Theory
Code for unit of study	M SES T
Teaching Term	Semester 1 / Semester 2
Credits/study load	7.5 EC / 210 h.
Study hours (contact hours)	64 hours + 6 contact hours exam (2 written exams)
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Analyze and disseminate Sustainable Energy Technology & Energy systems modelling and understand energy and environmental policy and regulation implications
(Professional) products	-

General description	The course sustainable energy systems technology gets the student familiar with several sustainable energy technologies. It covers the following topics:
	
	- Electrical energy generation
	  o Overview of energy generation technologies
	  o Solar energy (PV & CSP)
	  o Wind energy
	- Storage & conversion of electrical energy
	  o Overview of grid storage technologies
	  o Battery storage
	  o Hydrogen applications
	
	The course sustainable energy systems integration covers the following topics:
	
	- Modelling, scenarios & application of energy
	  o Explore existing modelling tools for creating future scenarios
	  o Introduction into energy modeling of moderate complexity
	- Heat applications
	  o Conventional thermal generation & biomass
	  o Waste heat & heat storage
	  o Heat pump systems & cooling.
	  o Applications in the built environment & industry
	- Environment, emissions & regulation:
	  o Emission calculations & protocols such as the European Emission Trading System (ETS)
	  o Emission verification

	o Overview policy instruments & outlook - Markets & stakeholders: o Introduction to electricity markets o Energy market overview, business and geopoliti implications o Stakeholder, who are the main relevant stakeholders
Compulsory literature	Energy Survival guide Insight and Outlook / 1th Edition 2011 Author, J. Hermans, Publisher: Leiden Publications ISBN 9789087281236 Fuel Cell Handbook / 7th Edition 2004 US Department of Energy, Department of Fossil Energy https://www.netl.doe.gov/File%20Library/research/coal/energy%20systems/fuel%20cells/FCHandbook7.pdf Handouts
Recommended literature	Not applicable
Required software	Relevant software will be made available (a.o. EnergyTransitionModel)
Relationship	Units of study Sustainable Energy Systems
Compulsory participation	Attendance will be registered for regular classes and contact moment.
Activities and instructional formats	Self-study, discussion of literature, assignments and exercises.
Examinations	
Final Qualifications	C1 Analyzing and defining problems
Assessment dimensions / learning outcomes	M SES T WE assessment dimensions: ¶ Knowledge and understanding analysis, fundamentals and applications Learning outcomes: ¶ The student has developed knowledge and understanding of the fundamentals of sustainable energy systems and its applications. ¶ Is able to apply, analyze and evaluate wind & solar energy and storage applications problems ¶ Is able to apply, analyze and evaluate thermal energy conversion and CO2 emissions & emissions trading system problems, general energy policy questions and can distinguish and make relevant observations on stakeholder problems.

	¶ Can distinguish (engineering) bottlenecks in an energ system and propose improvements to the system. ¶ The student has developed an understanding of the societal impact of sustainable energy and the context regulations. M SES T HTE assessment dimensions: ¶ Knowledge and understanding analysis, fundamentals and applications Learning outcomes: ¶ The student is able to use energy modelling to formulate strategies and work on moderately complex energy scenario problems in the form of an assignment ¶ The student is able to compare and draw conclusions the outcomes of an assignment on moderately compl energy scenario problems
Assessment criteria	M SES T WE The student will be assessed on answering the questions: ¶ Clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ Without irrelevant additional information ¶ Using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ Using correct units for quantities in equations, graph labels, etc. M SES T HTE There is a separate modelling assignment given by the teach during the teaching of the modelling subject within the sustainable energy systems integration course. The assignm is examined by the examiner familiar with the modelling subject. Criteria assessed in the assignment made by the student are ¶ Strategies are well formulated, consistent and contai sufficient variables per strategy ¶ Scenarios are established based on strategies containing explained choices and sufficient detail ¶ The comparison between the scenarios and discussi and conclusions are formulated clearly ¶ Judgements and decisions are supported and reporting is concise, complete, unambiguous and readable
Information for each exam and modular exam	

Examinations	Exam code	M SES T WE1	M SES T WE 2	M SES T HTE
		Week1.9 / 3.9	Week 2.9 / 4.9	Week 2.9 / 4.9
	First examiners: Rik Catau, Marc v.d. Sluijs			
	Exam method	Written exam	Written exam	Home taken exam
	Permitted resources	Non-graphical calculator		PC
	Number of examiners	At least 1		1
	Assessment	Mark	mark	Mark
	Pass mark	55	55	55
	Minimal result	45	45	55
	Weight	5	4	1
	Reassessment	1	1	1
	Compensation	yes		no
	Review	Week2.4 / 4.4	Week 3.4 / 4.12	
Other information				
Required classroom	Regular classroom			

Unit of Study (UoS) M SES CS	Capita Selecta
General Information	
Name of unit of study	Capita Selecta
Code for unit of study	M SES CS
Teaching Term	Semester 1 / Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	32 contact hours + 1 hour presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Studying scientific Literature on the relevant and actual subjec
(Professional) products	Presentation on subject
General description	Relevant literature is provided and papers are discussed in a journal club.
Compulsory literature	Handouts and papers
Recommended literature	-
Software and other materials	-
Relationship	Units of study Sustainable Energy Systems
Compulsory participation	Presence at colloquia, journal club meetings and presentations is mandatory.
Activities and instructional formats	Self-study, discussion of literature. Work Forms: Lectures, Colloquia and Journal Club
Examinations	
Final Qualifications	C5 Conducting research
Assessment dimensions / learning outcomes	Assessment dimensions ¶ Knowledge and understanding: analysis, fundamentals and applications ¶ Application and making judgments: structuring of research, design and testing ¶ Communication of knowledge; oral and in the form of a presentation Learning outcomes: The student is able to understand scientific literature and presents and discusses the contents with fellow students while providing a relevant context

Assessment criteria	The student will be assessed on the criteria (the questions) mentioned on an evaluation form which will be provided as part of the course material, which will be used as input for the final evaluation which is included on the next page.	
Information for each exam and modular exam		
Examinations	Exam code	M SES CS
		Week4.9
	First examiners	Marc v.d. Sluijs, Leon Bunthof
	Exam method	Presentation
	Permitted resources	Preferred presentation format
	Number of examiners	2
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Feedback after presentation, Evaluation form week 4.12
Other information		
Required classroom	Regular classroom	

Sustainable Energy Systems, Capita Selecta, Evaluation and Awarding Marks

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Unit of Study (UoS) M SES MP	Sustainable Energy Systems Minor Project
General Information	
Name of unit of study	Sustainable Energy Systems Minor Project
Code for unit of study	M SES MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	32 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	The professional task consists of: - Design an Energy system, make a model and compute outp - Determine economic and social, legal viability of energy system(s)
(Professional) products	An intermediate project report on the design of an energy system including modelling & computation of its output. A final project report on one or multiple (sustainable) energy systems regarding economic, social and legal feasibility
General description	The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications. It will be given in two parts: part one focuses on the sustainable energy technology. Part two focuses on the sustainable Energy System Integration. The project covers the following topics: ¶ The problem to be solved requires an understanding and active analysis of distinctive disciplines. ¶ The project will always include the step from a real-life problem to a more abstract representation of the problem. Required results are described under the professional product section. The problem analysis will result in a problem solution to be translated in such terms that conclusions can be drawn based on the extent the problem has been solved and objectives fulfilled.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordhc Uitgevers, ISBN 9789001790929

	Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	-
Relationship	Units of study Sustainable Energy Systems
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment Development and analysis of (sustainable) energy system(s) by working on a problem with fellow student.
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Knowledge and understanding: analysis, fundamentals and applications ¶ Application and making judgments: structuring of research, design and testing ¶ Communication of knowledge, oral and in the form of a presentation and in a report ¶ Conducting research and generating working hypotheses ¶ Organizing work processes and implementing communication and collaboration ¶ Learning skills (professional development) Learning outcomes (general): ¶ The student presents a clear justification of the project approach. ¶ The student plans effectively. ¶ The student carries out a project based on a real-life problem in which model development and analysis as w as experimental validation are essential parts by applyir

	knowledge and understanding and making judgements based on analysis and validation techniques. ¶ The student structures the working process in the engineering domain and is able to effectively communic the core findings in a structured and convincing way. ¶ The student is able to systematically search for information, such as e.g. models, and judge its relevance. ¶ The student communicates the project findings in a clea and structured manner with colleague, customers and th wider public in oral and written forms. The content has been reviewed by peers and/or supervisor. ¶ The student reflects on his/her role in the project and on his/her professional development. Learning outcomes (specific): ¶ The student can critique on and analysis of problems in the field of energy system design, system simulation and testing, feasibility study. ¶ The student evaluates energy models and make informed decisions based on scenario information. ¶ The student creates a proposal for improvement on an analyzed and evaluated energy system or plan a new design for an energy system; taking into account use of renewable resources, energy efficiency and environmental sustainability.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not receive a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their proj group regularly.

Information for each exam and modular exam			
Examinations	Exam code	M SES MPSC	M SES MPDP
		Week 2.10 / 4.10	
	First examiners: Rik Catau, Marc v.d. Sluijs, Leon Bunthof		
	Exam method	Group contribution	Documentation / Presentation
	Permitted resources	Presentation software, report, spreadsheet or Matlab/Simulink/HOMER files allowed as result.	
	Number of examiners	2	
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	1, week 4.11/4.12	
	Compensation	No	
	Review	Feedback after presentation and evaluation form week 4.12	
Other information			
Required classroom	Regular classroom		

Sustainable Energy Systems: Project Documentation and Presentation
Evaluation and Awarding Marks
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Module M SFEE	Sustainable Fuel, Engines and Emissions
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Adam Daya
Professional Task	Understand, analyze and contribute to technical and societal aspects of sustainable fuels, engines and emissions, and their interactions.
Professional Products	Project plan (project) Report (project and capita selecta) Presentation (progress and final) Test plan and test report (project) if appropriate
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Module Systems Modelling Preferred: basic knowledge of ICE/thermodynamics
General Description	In this module the student will gain knowledge on analyzing combustion engines and fuels, concerning: emissions, performance, fuel consumption, environmental sustainability, chain sustainability, efficiency, (costs) or any other relevant asp Theory In the theory part the student will gain knowledge of physics required for analyzing combustion engines. The principal functioning of the engine and its subsystems will be studied. Modelling of engines will be done by using white box modelling. Furthermore attention will be paid to the relation between engin behavior and fuel properties, which ties in to the theme of sustainability where alternative/renewable fuels are investigated. Relevant control methods will be covered and the influence of software calibration on the engine behavior will be studied. Applying in project The theory learned will be implemented in a project. Modelling will be done at the appropriate level of detail. For validation experimental data can be used. Depending on the chosen proje application or calibration will be done at an engine testbed or HIL/MIL/SIL setup. Project results and conclusions will be presented in a report and explained orally.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Sustainable Fuel, Engines and Emissions Theory (7.5 EC) Sustainable Fuel, Engines and Emissions Capita Selecta (2.5 EC) Sustainable Fuel, Engines and Emissions Project (5 EC)

Unit of Study (UoS) M SFEE T	Sustainable Fuel, Engines and Emissions: Theory
General Information	
Name of unit of study	Sustainable Fuel and Engines: Theory
Code for unit of study	M SFEE T
Teaching Term	Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	64 contact hours + 6 contact hours exam (written exam WE 1 / 2)
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Concept design and analysis of engines and fuels
(Professional) products	Not applicable
General description	The course covers the following topics: ¶ The combustion engine as a system ¶ Engine subsystems, components and processes ¶ Modelling of combustion engines ¶ Analyzing different fuels and their effects on the engine, the combustion process ¶ Analyzing the complete chain sustainability of alternativ fuels ¶ Control aspects and calibration of combustion engines ¶ Fuel chain sustainability ¶ Environmental sustainability, Well-to-Wheel (WTW) emissions and the impact of CO_2
Compulsory literature	Heywood, Internal Combustion Engines Fundamentals 2E, ISB 978-1260116106 Lecturing materials and handouts on Onderwijs Online
Recommended literature	Ghazi A. Karim, Dual-fuel DIESEL ENGINES (2015) CRC Press
Required software	Matlab, Simulink, GT Power
Relationship	M SFEE CS and M SFEE MP Module: Systems Modelling
Compulsory participation	No, but attendance will be registered

Activities and instructional formats	Lectures, Self-study, Working on (lab) assignments
Examinations	
Final Qualifications	C1 Analyzing and defining problems
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems) The student analyzes advanced and innovative configurations of engines and fuels and is able to make conceptual design choices concerning them. The student understands the application of alternative fuels in Internal Combustion Engines, as well as the influence of these on emissions, climate change, and fuel chain sustainability. The student is able to analyze the consequences for performance and emissions and can propose methods for further improvements. (WE1 & WE2) The student analyzes a problem in the field of combustion engines. In doing so, he applies modern Computer Aided Engineering (CAE) tools, also used frequently in the industry and applied research institutes. (SFEE HTE)
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations and models for the situation (for example when to use linear or nonlinear models) ¶ using correct units for quantities in equations, graph labels, etc. M SFEE WE1 and WE2: The WarmUp Test result given by the lecturer during the lecturing of the theory determines 20% of the score of the written (re-) exams. There are no separate WarmUp Tests for the re-exams.

Information for each exam and modular exam				
Examinations	Exam code	M SFEE ITE	M SFEE WE1	M SFEE WE2
		Week 4.6	Week 3.9	Week 4.9
	First examiner	Menno Merts / Hans van Vinne / Bram Veenhuizen / Adam Daya		
	Exam method	Assignment CAE	Written exam	Written exam
	Permitted resources	CAE	All/no laptop	All/no laptop
	Number of examiners	1	1	2
	Assessment	Mark	Mark	Mark
	Pass mark	55		
	Minimal result	45	45	45
	Weight	1	1	1
	Reassessment	August 15	August	August
	Compensation	yes		
	Review	Evaluation form week 4.12	Review Week 4.4	Review week 4.12
Other information				
Required classroom	Regular classroom, laboratory and computer class room			

Unit of Study (UoS) M SFEE CS	Sustainable Fuel, Engines and Emissions Capita Selecta
General Information	
Name of unit of study	Sustainable Fuel, Engines and Emissions Capita Selecta
Code for unit of study	M SFEE CS
Teaching Term	Semester 2
Credits/study load	2.5 EC / 56 hours
Study hours (contact hours)	16 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Understand and analyze the innovations in engines and fuels
(Professional) products	Documentation of the work, like report, models, data and presentation
General description	Make a thorough analysis of a peer reviewed scientific paper on innovations in engines or fuels.
Compulsory literature	Handouts
Recommended literature	-
Software and other materials	-
Relationship	M SFEE T and M SFEE MP Module: Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Self-study, case studies Work forms: Instruction on demand, reporting
Examinations	
Final Qualifications	C5 Conducting Research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Making judgements (conducting research) - Communication (conducting research) - Learning skills (conducting research) The student analyzes a scientific paper on sustainable fuels, engines and emissions and to identify its strengths and potential shortcomings.

	The student formulates a proposal for extending or enhancing the analyzed scientific research. The student understands the role of fuels and engines in the perspective of the modern, evolving society.	
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form.	
Information for each exam and modular exam		
Examinations	Exam code	M SFEE CS
		Week 3.9
	First examiner	Menno Merts /Hans vd Vinne/ Bram Veenhuizen / Adam Daya
	Exam method	Presentation and defense
	Permitted resources	Everything, but all results must ō Ŝ ű K Ŝ ă ű dz Ř Ŝ y˝ ű
	Number of examiners	2
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Feedback after presentation Evaluation form week 4.4
Other information		
Required classroom	Regular classroom	

Sustainable Fuel, Engines and Emissions Capita Selecta

Evaluation and Awarding Marks

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Unit of Study (UoS) M SFEE MP	Sustainable Fuel, Engines and Emissions: Minor Project
General Information	
Name of unit of study	Sustainable Fuel, Engines and Emissions: Minor Project
Code for unit of study	M SFEE MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	20 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Conducting literature research Modelling and validation
(Professional) products	Project plan Report Presentation
General description	¶ The students have to carry out an assignment, of which mo development and analysis as well as experimental validation are essential parts. The Project serves to challenge the students to apply their knowledge and skills on a real-life problem, in correspondence with a subset of the final qualifications and the course discusses the skills needed to perform a research project and includes performing a literature study.
Compulsory literature	-
Recommended literature	¶ Project Management, A Practical Approach, Roel Grit, Noordhoff Uitgevers, ISBN 9789001790929 ¶ Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Software and other materials	Matlab simulink, GT Power
Relationship	M SFEE T and M SFEE CS Module: Systems Modelling
Compulsory participation	yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research

	C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment - Applying knowledge and understanding (Analyzing and defining problems, Design, Conducting Research) - Making judgements (Analyzing and defining problems, Design, Conducting Research - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimenta validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search information, such as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider pub in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student is able to analyze a real life problem concerning engines and/or fuels. The student is able to create a model for an engine problem and/or fuel problem and perform a relevant analysis. The student is able to validate modelling results against the rea life situation and problem formulation. The student is able to formulate a proposal for improvement of engine problem and/or fuel problem and is able to make an assessment of its viability taken into account energy efficiency and environmental sustainability using proper techniques like prototyping, modelling or analysis.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form.

	To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peer review: each minor project group evaluates at least twice the contribution of the group members on conten and collaboration. If the outcome of the first peer review is negative for the individual student, the student still ha the opportunity to improve. If the result is negative agair during the second peer review, the student will not rece a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their proje group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M SFEE MBC	M SES MPP
		Week 4.10	
	First examiner	Menno Merts / Hans van Vinne/ Bram Veenhuizen / Adam Daya	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž NJ ļ	
	Number of examiners	2	
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	1	
	Compensation	No	
	Review	Feedback after presentation / evaluation form week 4.12	
Other information			
Required classroom	Regular class room		

Sustainable Fuel, Engines and Emissions Project Documentation and Presentation
Evaluation and Awarding Marks
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Module M SI	Smart Infrastructure
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Frans Tillema
Professional Task	Model and evaluate current mobility challenges to enable suitable advice and strategy.
Professional Products	Design/model of a high level architecture for Smart Infrastructu solution (HTE) Detailed design/model of a technical Smart Infrastructure soluti (MP) Intervention and advisory report (MP) Impact assessment report of new technology (CS)
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Entry requirements: Module Systems Modelling Relationship: Module Smart Vehicles
General Description	Smart Infrastructure deals with the design and deployment of new technological smart infrastructure related solutions to overcome the current negative externalities of traffic and transport i.e. loca air pollution, noise pollution, safety hazards, community severa and congestion. The module focuses on the following topics: - History of Intelligent Mobility - Traffic and transport modeling and simulations - Modelling of Smart traffic lights (+control) - Impact and relationship of transport modalities (MAAS) - Architecture of C-ITS solutions - Communication protocols of C-ITS - Data exchange - (Big)Data in traffic and transport - Smart logistics - Governance/Policy of Smart Infrastructure systems - Privacy and Security - Societal impact of Smart Infrastructure solutions - Human behavior with respect to technology - Infrastructure adaptation
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	SmartInfrastructure T (7.5 EC) Smart Infrastructure CS (2.5 EC) Smart Infrastructure minor project (5.0 EC)

Unit of Study (UoS) M SI T	Smart Infrastructure T
General Information	
Name of unit of study	Smart Infrastructure T
Code for unit of study	M SI T
Teaching Term	Second semester
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	60 h. term 3 and 3 contact h. written exam
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Model and Apply smart infrastructure technology to optimize the traffic and transport system
(Professional) products	Design of a high-level architecture for a new Smart Infrastructure solution
General description	The theory focuses on the following topics: - History of Intelligent Mobility - Traffic and transport modeling and simulations - Modeling of Smart traffic lights (+control) - Impact and relationship of transport modalities (MAAS) - Architecture of C-ITS solutions - Communication protocols of C-ITS - Data exchange - (Big) Data in traffic and transport, AI and Deep learning - Smart logistics - Governance/Policy of Smart Infrastructure systems - Privacy and Security - Societal impact of Smart Infrastructure solutions - Human behavior with respect to technology - Infrastructure adaptation Theory consist of the following sub-courses: - Multi Modal Traffic Management and I-C-ITS (112 h.) - Governance of Intelligent Mobility (42 h.) - Societal Impact and Behavior (56 h.)
Compulsory literature	Lecturing material and hand-outs (Power Point, on Onderwijs Online)
Recommended literature	-
Required software	-
Relationship	Units of study Smart Infrastructure
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments Work Forms: Lectures

Examinations		
Final Qualifications	C1 Analyzing and defining problems C5 Conducting research	
Assessment dimensions/ learning outcomes	Dimensions of assessment: - Knowledge and understanding (Conducting Research, Analyzing and defining problems on optimizing the traffic and transport system) The student applies smart infrastructure technology to optimize the traffic and transport system The student analyzes multidisciplinary factors of influence of the ecosystem (Sociological, psychological, political, technological)	
Assessment criteria	The student will be assessed (M SI T WE) on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations, models and graphs, including labels and units, for the situation (for example when to u linear or nonlinear models)	
Information for each exam and modular exam		
Examinations	Exam code	M SI T WE
		Week 3.9
	First examiner: Frans Tillema / Chris Huijboom/Marith Dieker/ Gijs van Stekelenburg	
	Exam method	Written exam
	Permitted resources	Everything, but all results Ydzăú ōŜ úKŜ ă work
	Number of examiners	1
	Assessment	mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Week 4.4
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SI CS	Smart Infrastructure CS
General Information	
Name of unit of study	Smart Infrastructure CS
Code for unit of study	M SI CS
Teaching Term	Second semester
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	20 contact hours
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Analyze current negative externalities of traffic and transport i.e local air pollution, noise pollution, safety hazards, community severance and congestion, analyze the impact of new technolo and relate to: Å Human Behavior Å Machine Behavior Å Psychology Å Ethics
(Professional) products	Article/Report on impact assessment of new technology
General description	The students will work on a few case studies that are based on scientific papers.
Compulsory literature	Handouts
Recommended literature	-
Software and other materials	
Relationship	Units of study Smart Infrastructure
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, case studies Work forms: interactive feedback lectures
Examinations	
Final Qualifications	C5 Conducting Research
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (conducting research) - Making judgements (conducting research)

	- Communication (conducting research) The student analyzes current negative externalities of traffic an transport i.e. local air pollution, noise pollution, safety hazards, community severance and congestion and analyzes the impact new technology and relate to: Human Behavior, Machine Behavi Psychology and Ethics The student writes a literature study report about developments in smart infrastructure with a trailer, a main text, a conclusion, a discussion and references. The student specifies references according a literacy standard. The student determines the validity of a referenced resources.	
Assessment criteria	The student will be assessed on the criteria (questions) mentio on the evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M SI CS
		Week 46
	First examiner	Frans Tillema / Marith Dieker / Gijs van Stekelenburg
	Exam method	Home taken exam: Article
	Permitted resources	Everything, but all results must ō Ŝ ű Ḱ Ŝ ă ű dz Ř Ŝ ŷ ű
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Evaluation form week 410
Other information		
Required classroom	Regular classroom	

SI:Capita Selecta Evaluation and Awarding Marks
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Unit of Study (UoS) M SI MP	Smart Infrastructure Minor Project
General Information	
Name of unit of study	Smart Infrastructure Minor Project
Code for unit of study	M SI MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	64 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Model and evaluate a new technical smart infrastructure solutio
(Professional) products	Detailed design of a technical Smart Infrastructure solution Policy Intervention advisory report
General description	SI-MP deals with modelling and evaluation of a new technological smart infrastructure related solution to overcome the current negative externalities of traffic and transport i.e. local air pollutio noise pollution, safety hazards, community severance and congestion. In a practical case, guided by one of the participating government of private companies, students are stimulated to work together with professionals on a real life smart infrastructure case, e.g.: - Introduction of new C-ITS technology on junctions - Introduction of connected logistics - Introduction of smart vehicles Students ale challenged to model the problem on a functional level, model the technical solution on a functional and profound level and evaluate the impact on negative externalities.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordho Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	-
Relationship	Units of study Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment
Examinations	

Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and defining problems, design and conducting research) - Making judgements (analyzing and defining problems, design, testing, conducting research) - Communication (managing work processes, communication and collaboration) Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the results/findings in a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider public in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student evaluates future smart (infrastructure) mobility solutions.
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 1. A group mark will be defined by the examiners. 2. Peerreview: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. if the outcome of the first peer review

	is negative for the individual student, the student still ha the opportunity to improve. If the result is negative again during the second peer review, the student will not recei a pass and therefore no final grade. 3. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their pro group regularly.			
Information for each exam and modular exam				
Examinations	Exam code	M SI MP PP	M SI MP GC	M SI MP DP
		Week 4.1	Week 4.10	
	First examiner	Frans Tillema / Marith Dieker / Gijs van Stekelenburg		
	Exam method	Project Plan	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ ŷ ŵ ŏ Ǎ ƨ ǿ ŷ		
	Number of examiners	1	2	
	Assessment	Pass	pass	Mark
	Pass mark	V	pass	55
	Minimal result	V	pass	55
	Weight	0	0	1
	Reassessment	1 (week 4.4)	1, (week 4.11 / 4.12)	
	Compensation	No		
	Review	Feedback week 4.3	Feedback after presentation / evaluation form week 4.12	
Other information				
Required classroom	Regular classroom			

Project Smart Infrastructure: Project Documentation and Presentation, Evaluation and Awarding Marks
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	Mark	Motivation	Weight factor
Applying knowledge and understanding C1: Analyzing and defining problems C2: Design C5: Conducting Research Does the candidate show sufficient familiarity with current knowledge? Have the central questions been answered? Are the methods and techniques properly used? Does the student show sufficient analytical skills to master the problem at hand?			1
Making judgments C1: Analyzing and defining problems C2: Design C3: Testing C5: Conducting Research Has critical appraisal been successfully incorporated Is the student able to correctly interpret and evaluate the quality?			1
Communication C4: Managing work processes C6: Communication and Collaboration Is the student able to present the results to a problem owner? Is the student able to work in a project team? Is the text clearly understandable and in grammatically sound language? Have the formal requirements for literary sources been met?			1
Learning Skills C7: Professional development Does the student display discernible eagerness to tackle the task? Is the problem owner involved adequately? Does the student show problem solving skills? Is the student self-reliant? Does the student reflect on the choices?			1
Final Mark (group) For a pass all marks should be sufficient			

Date : Signature examiner: Signature examiner

Module M SPS	Smart Power Supply
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	BallardAsareBediako
Professional Task	Understand, apply and analyze aspects related to power supply grid stability in a changing energy system, create and evaluate power supply models
Professional Products	Models
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling, Sustainable Energy Systems
General Description	In this module the student learns to understand aspects of the energy supply system (generation, transmission and distribution systems), which is changing towards a complex system with centralized and localized sustainable energy production. Students will understand and be able to apply fundamentals of power supply: ¶ Basics of the current energy grid, power supply and as ¶ Understand consequences of the energy transition for electrical grid stability ¶ Understand the concept of interchangeability of power and heat/gas as energy ¶ Select and apply optimization algorithms for energy management ¶ Model and simulate power control (systems) ¶ Analyze, interpret and mitigate power quality problems ¶ Analyze and design asset management of power syste ¶ Apply knowledge to expected and existing energy grid problems
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	This module consists of the following units: ¶ Energy Management (2.5 EC) ¶ Power Control (2.5 EC) ¶ Power Quality (2.5 EC) ¶ Asset Management (2.5 EC) ¶ Minor Project (5 EC)

Unit of Study (UoS) M SPS EM	Energy Management
General Information	
Name of unit of study	Energy Management
Code for unit of study	M SPS EM
Teaching Term	Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	16 contact hours
Entry requirements	Simultaneously to the Module Sustainable Energy Systems or aft taking classes Sustainable Energy Systems, Power Control.
Objectives and instructional formats	
Professional task	Analyze and design optimization algorithm(s) for energy system a (micro)grid.
(Professional) products	Various case studies
General description	This course covers the following topics: - Power systems structure (physical, economic and regulator layers) - Energy optimization: methods, constraints, boundaries, etc. - Economic dispatch and unit commitment: application to the power systems. - Smart Grids: Balancing throughout the power system value chain - Grid Evolution & Cyber security.
Compulsory literature	Lecture notes (to be distributed during the lectures) and scientifi papers
Recommended literature	*Antonio J. Conejo; Luis Baringo, Power System Operations, Springer, ISBN: 978-3-319-69406-1, 978-3-319-69407-8*
Required software	Matlab, Excel, Vision Network Analysis
Relationship	Units of study Smart Power Supply
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Lectures, (company) guest lectures, self-study and case studies, based on scientific papers.
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design
Assessment dimensions / learning outcomes	Dimensions of assessment: - Knowledge and understanding (analyzing and defining problems, making judgements) - Applying Knowledge and understanding (design)

	The student explains the different layers of the energy supply systems (physical, economic and regulatory The student differentiates, tests and implements optimization algorithms for energy management making trade-offs between technical and economic measures and taking into account the regulatory aspects. The student recognizes and describes the Smart Grid concept a able to design and implement the desired configuration(s) and the control system in a power system value chain	
Assessment criteria	The student will be assessed on the criteria (questions) mentio on the evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M SPS EMITE
		Week 49
	First examiner	Ballard Asare Bediako
	Exam method	Home-taken exam case study
	Permitted resources	Everything, but all results must ō Ŝ ű K Ŝ ă ű dz Ř Ŝ y˝ ű
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	August 15
	Compensation	no
	Review	Evaluation form week 412
Other information		
Required classroom	Regular classroom	

Smart Power Supply, Energy Management, Evaluation and Awarding Marks

Name, first name and student number: X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

	Mark	Motivation	Weight factor
Knowledge and understanding C1: Analyzing and defining problems Can the student explain the demand-supply concept in the energy supply system? Can the student analyze if the given set of consumption data and generation units are enough to answer the formulated question? Can the student apply appropriate techno-economic optimization algorithms to match demand and supply?			1
Applying knowledge and understanding C2 Design Can the student design a model with available simulation tools for the given question? Can the student design a model and apply appropriate simulation tools, matlab, vision, etc. to solve the given problem? Can the student apply economic dispatch and unit commitment to find techno-economic optimum for a given demand and supply dataset? Does the student deal with missing or erroneous data correctly?			1
Making judgments C1: Analyzing and defining problems Can the student evaluate and compare models and optimization techniques? Can the student motivate the choice of an optimization algorithm? Can the student motivate the assumptions made and explain the results of the model simulations?			1
Mark total			

Date : Signature examiner :

Unit of Study (UoS) M SPS PC	Power Control (Capita Selecta)
General Information	
Name of unit of study	Power Control
Code for unit of study	M SPS PC
Teaching Term	Term 3
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	16 contact hours
Entry requirements	After taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Create models, perform control and analyze technical performance of a power system
(Professional) products	Various case studies
General description	This course covers the following topics: - Introduction to electrical circuits o Use of complex numbers for solving electrical circuits o AC electrical circuits, RMS values and phasors o Resistance, inductance, capacitance. Relationships between currents and voltages for basic circuit elemen o OhY Ω ă ƭ ł ǿ Σ Y ƛ NJŎ Ƙ Ƙ ƻ Ŧ Ŧ Ǿ ƻ ƭ ǘ o Active and reactive power o Single phase and three phase networks Electrical circuit analysis as a basis for power system analysis - Introduction to power systems o Structure of power systems, grid buildup and hierarchy o Transient phenomena and time scales o Overview of basic power system components and thei models o Per unit system and basic power system calculations - Steady-state analysis of power systems o Power balance and power flow calculations o Voltage magnitude and angle, relation to active and reactive power flows - Synchronous generators o Principle of work o Introduction to synchronous generator control and different control modes o Generator capability limits and PQ-curves o Use of synchronous generators at biomass or pv plants - Inverter-based generators o Introduction to inverters and their controls o Photovoltaic (PV) panels and solar parks o Wind turbines, their types and control - Principles of power system control o Voltage and frequency control o Network-connected and island operation modes

Compulsory literature	To be announced	
Recommended literature	To be announced	
Software and other materials	MATLAB, Vision Network Analysis	
Relationship	Units of study Smart Power Supply	
Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Lectures, (company) guest lectures, self-study and case studies based on scientific papers.	
Examinations		
Final Qualifications	C1 Analyzing and defining problems C2 System Design	
Assessment dimensions / Learning outcomes	Dimensions of assessment: Knowledge and understanding (analyzing the problem) Applying knowledge and understanding (Design) Making judgements (analyzing the problem) The student is able to construct a model of a power system The student can solve power balance problems and perform technical analysis of a power system performance. The student understands and is able to explain principles used for power system control	
Assessment criteria	The student will be assesses on the criteria (questions) on the evaluation form (next page).	
Information for each exam and modular exam		
Examinations	Exam code	M SPS PC HTE
		Week 3.9
	First examiner	Ballard Asare Bediako
	Exam method	Home taken exam
	Permitted resources	Everything, but all results must ō Ŝ ű Ǩ Ŝ ă ű dz Ř Ŝ y ́ ú
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	August 15
	Compensation	no
	Review	Evaluation form 4.4
Other information		
Required classroom	Regular classroom	

Smart Power Supply, Power Control Evaluation and Awarding Marks
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Unit of Study (UoS) M SPS PQ	Power Quality
General Information	
Name of unit of study	Power Quality
Code for unit of study	M SPS PQ
Teaching Term	Term 4
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	16 contact hours + 3 contact hours exam
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling, Power Control, Sustainable Energy Systems
Objectives and instructional formats	
Professional task	Analyze, evaluate and develop solutions for power quality problems
(Professional) products	Various case studies
General description	This unit deals with the quality of the public electricity grid and electrical installations in general. The use of nonlinear loads and sensitive electronic equipment in the industry, commercial sectors and the domestic environments increased considerably over the last decades. Unfortunately, the same type of equipment often generates disturbances in the energy supply, which in turn affect other devices negatively and give rise to poor power quality. Both theoretical and practical aspects are discussed: ¶ What is power quality and why it is important; ¶ Cost of power quality; ¶ Review of electrical circuits and quantities; ¶ Power quality phenomena (dips, transients, harmonics, flicker); ¶ Fourier theory; ¶ Efficiency and power factor; ¶ Asymmetry and unbalance; ¶ Norms; ¶ Monitoring and analysis; ¶ Power conditioning.
Compulsory literature	Lecture notes (to be distributed during the lectures) and relevant scientific papers
Recommended literature	To be announced
Software and other materials	Matlab, Excel and Power Quality Teaching Tools by PSL. Free available at http://www.powerstandards.com
Relationship	Units of study Smart Power Supply

Compulsory participation	No, but attendance will be registered	
Activities and instructional formats	Lectures, (company) guest lectures, self study and case studies.	
Examinations		
Final Qualifications	C1 Analyzing and defining problems C2 System Design	
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (System Design) - Making judgements (Analyzing and defining problems) The student is able to understand the various aspects of power quality. The student applies the obtained knowledge and skills to a real life power quality problem. The student is able to analyze power quality problems and develop solutions	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations, models and graphs, including labels and units, for the situation (for example when to use linear or nonlinear models)	
Information for each exam and modular exam		
Examinations	Exam code	M SPS PQ WE
		Week 4.9
	First examiner	Dimitri Jeltsema / Ballard Asare Bediako
	Exam method	Written exam
	Permitted resources	None
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Week 4.12
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SPS AM	Asset Management
General Information	
Name of unit of study	Asset Management
Code for unit of study	M SPS AM
Teaching Term	Term 3
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	16 contact hours and 3 contact hours exam
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Analyze and design asset management of power system
(Professional) products	Various case studies
General description	This course covers the following topics: - Asset management – why? Philosophies and organization o The created value of energy systems o AM purpose and approach o AM standards and organization - Materials for grid components and ageing mechanisms o Components in the grid o Conductors and semi-conductors o Insulators and field control o Ageing mechanisms and failure o Material and forensic investigations - Maintenance and Incident management o Maintenance concepts o Incidents and emergencies o Descriptive statistic o Inferences: predicting future reliability and failures o Uncertainty and confidence
Compulsory literature	¶ R. Ross, Reliability Analysis for Asset Management of Electric Power Grids, John Wiley, (eBook ISBN: 978-1-119-12519-8; hard copy: ISBN: 978-1-119-12517-4) ¶ reader Material analysis (free pdf)
Recommended literature	IAM: Asset Management – an anatomy
Software and other materials	Matlab, Excel, Vision Network Analysis
Relationship	Units of study Smart Power Supply
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Lectures, (company) guest lectures, self-study and case studies.
Examinations	

Final Qualifications	C1 Analyzing and defining problems C2 Design	
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and Design systems) The student is able to apply Asset Management methodology to power grids. The student is able to evaluate the suitability of materials and investigate aspects related to failure research and forensic studies. The student is able to judge and formulate maintenance concepts. The student is able to formulate confidence boundaries and significance.	
Assessment criteria	The student will be assessed on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations, models and graphs, including labels and units, for the situation (for example when to u linear or nonlinear models)	
Information for each exam and modular exam		
Examinations	Exam code	M SPS AM WE
		Week 39
	First examiner	Rob Ross, Ballard Asare Bediako
	Exam method	Written exam
	Permitted resources	-
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	no
	Review	Week 44
Other information		
Required classroom	Regular classroom	

Unit of Study (UoS) M SPS MP	Smart Power Supply Minor Project
General Information	
Name of unit of study	Smart Power Supply Minor Project
Code for unit of study	M SPS MP
Teaching Term	Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	28 contact hours and 4 contact hours presentation
Entry requirements	Simultaneously to the Module Systems Modelling or after taking classes Systems Modelling
Objectives and instructional formats	
Professional task	Create models of a selected problem related to expected chang from the energy transition onto the energy grid
(Professional) products	A project report on the modelling of the selected problem including a detailed analysis of the obtained results from simulations using the model.
General description	The Project serves to challenge the students to apply their The project serves to challenge the students to apply their knowledge and skills on an expected or existing real-life problem, in correspondence with a subset of the final qualifications The project covers the following topics: ¶ The problem to be solved requires an understanding and active analysis of distinctive disciplines. ¶ The project will always include the step from a real-life problem to a more abstract representation of the problem in order to be able to create a model ¶ The project also asks to simulate different conditions and/or options using the model, and to translate the results back to the real life situation. Required results are described under the professional product section. The problem analysis will result in a problem solution to be translated in such terms that conclusions can be drawn based on the extent the problem has been solved and objectives fulfilled.
Compulsory literature	Project Management, A Practical Approach, Roel Grit, Noordhc Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591
Recommended literature	-
Software and other materials	-

Relationship	Units of study Smart Power Supply
Compulsory participation	yes
Activities and instructional formats	Research Work Forms: Lectures, Assignment Development and analysis of an energy grid related problem by working in a team on a problem.
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (analyzing and defi problems, design, testing, conducting research) - Making judgements (conducting research) - Communication (managing work processes, communication and collaboration) - Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real life problem in which model development and analysis as well as experimenta validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider pub in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student is able to analyze real life problems concerning effects of energy transition on the power systems.

	The student is able to design a power system related model an perform simulations and tests. The student is able to interpret results from simulations and tes and develop solutions to the problem.		
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 7. A group mark will be defined by the examiners. 8. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. If the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not rece a pass and therefore no final grade. 9. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their pro group regularly.		
Information for each exam and modular exam			
Examinations	Exam code	M SPS MPGC	M SPS MPPP
		Week 4.10	
	First examiner	Ballard Asare-Bediako	
	Exam method	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă 2 ø y˝ ø 2 NJ ļ	
	Number of examiners	2	
	Assessment	Pass	Mark
	Pass mark	Pass	55
	Minimal result	Pass	55
	Weight	0	1
	Reassessment	1, week 4.11/4.12	
	Compensation	No	
	Review	Feedback after presentation Evaluation form: week 4.12	
Other information			
Required classroom	Regular classroom		

Smart Power Supplies: Project Documentation and Presentation, Evaluation and Awarding Marks
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Module M SV	Smart Vehicles
Degree program	Master Engineering Systems
Target Group	Elective module
Coordinating lecturer	Chris Huijboom
Professional Task	Assess, design and implement new technologies for connected and automated transport, in the car, bus, bike and other transport mode
Professional Products	Design/model of a high-level architecture for smart vehicles and other transport modes Detailed design/model of a technical smart vehicle solution Detailed implementation plans and deployment strategy plan Impact assessment report of new technology
Credits / Study load	15 EC / 420 hours
Relationship with and entry requirements concerning examinations	Entry requirements: Module Systems Modelling Relationship: Module Smart Infrastructure
General Description	Smart Vehicles deals with (1) the design and implementation of new technologies for connected and automated transport, in the car, bus, bike and other transport modes and (2) assessing the implementation of such technologies, keeping in mind their various capabilities, vehicle types, performance, functional design, security and privacy concerns, as well as the interplay between the vehicle and its human users The module focuses on the following topics: Vehicle Technology: Sensor Technologies and their Environmental Perception, Vehicle Automation (incl. ADAS) & Integration and Embedding of smart vehicle concepts. Talking Traffic: IoT, Talking Traffic, 4G 5G GNSS WIFIP, Augmented/ Virtual Reality AI and Deep learning: Machine learning, A.I. and Deep Learning Societal and Behavioural Impact: Human environmental Perception and Interpretation, Human Behavior, Human Machine Interface, Machine Behavior, Psychology and Ethics Governance and Procurement: Functional Safety, Legal Aspects, Cybersecurity and Privacy Concerns
Final Qualifications	C1 Analysing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Smart Vehicles Theory 7.5 EC Smart Vehicles Minor Project 5.0 EC Smart Vehicles Capita Selecta 2.5 EC

Unit of Study (UoS) M SV T	Smart Vehicles T
General Information	
Name of unit of study	Smart Vehicles T
Code for unit of study	M SV T
Teaching Term	Semester 1 / Semester 2
Credits/study load	7.5 EC / 210 hours
Study hours (contact hours)	60 h.term 1/3 and 2/4 h. + 6 contact hours exam (2 exams)
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Assess, design and implement new technologies for connected and automated transport, in the car, bus, bike and other transport mode
(Professional) products	Design/model of a high-level architecture for smart vehicles and other transport modes
General description	The theory focuses on the following topics: Å Vehicle technology Å Sensor Technology Å Sensor Environmental Perception Å Vehicle Automation (inclusive ADAS) Å Integration and Embedding of SV concepts Å Talking Traffic Å IoT Å Talking traffic Å 4G 5G G5 WIFIP Å Augmented /Virtual Reality Å AI and Deep learning Å Machine Learning Å Artificial Intelligence & Deep Learning Å Societal and behavioral impact Å Human environmental Perception and Interpretation Å Human Machine Interface Å Human Behavior Å Machine Behavior Å Psychology Å Ethics Å Governance and Procurement Å Functional Safety Å Legal Aspects Å Cybersecurity Å Privacy Concerns
Compulsory literature	Lecturing material and handouts (Power Point, on #OO)
Recommended literature	Mentioned in lectures and on #OO
Required software	MATLAB & Simulink, PreScan
Relationship	Units of study Smart Vehicles
Compulsory participation	No, but attendance will be registered
Activities and instructional formats	Self-study, Working on assignments Work Forms: Lectures and interactive discussions

Examinations			
FinalQualifications	C1 Analysing and defining problems C5 Conducting research		
Assessments dimensions / learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (Conducting Resea Analysing and defining problems) The student is able to analyze, synthesize and evaluate (WE1 & WE2): - Vehicle Technology - A.I. & Deep Learning - Talking Traffic - Societal and Behavioural Impact - Governance and Procurement		
Assessment criteria	The student will be assessed (M SV T WE1 & WE2) on answering the questions: ¶ clearly and to the point, including sufficient relevant explanation and depth, comparable with the depth of the literature studied ¶ without irrelevant additional information ¶ using correct equations, models and graphs, including labe and units, for the situation (for example when to use linear o nonlinear models)		
Information for each exam and modular exam			
Examinations	Exam code	M SV T WE1	M SV T WE2
		Week 1.9 /3.9	Week 2.6/4.6
	First examiner	Chris Huijboom / Frans Tillema / Marith Dieker/ Bas Hetjes	
	Exam method	Written exam	Written exam
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω ă ž ø y˝ ø ž NJ ł	
	Number of examiners	2	2
	Assessment	mark	mark
	Pass mark	55	
	Minimal result	45	45
	Weight	1	1
	Reassessment	1	1
	Compensation	Yes	
	Review	Week 2.4/4.4	Week 2.9/4.9
Other information			
Required classroom	Regular classroom		

Unit of Study (UoS) M SV CS	Smart Vehicles CS
General Information	
Name of unit of study	Smart Vehicles CS
Code for unit of study	M SV CS
Teaching Term	Semester 1 / Semester 2
Credits/study load	2.5 EC / 70 hours
Study hours (contact hours)	20 contact hours
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Analyse current state of the art with respect to: ¶ Connectivity standards ¶ Technology ¶ Security ¶ Privacy ¶ Impact & perspective (impact it may have on behaviour aspects)
(Professional) products	Literature review report
General description	The students will deepen the theory of Smart Vehicles and extend their knowledge with relevant, actual topics by conducting a literatu review based on scientific paper.
Compulsory literature	-
Recommended literature	-
Software and other materials	-
Relationship	Units of study Smart Vehicles
Compulsory participation	Yes
Activities and instructional formats	Self-study, case studies Work forms: Lectures, interactive exercises, reporting
Examinations	
Final Qualifications	C2 Design C5 Conducting Research

Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Applying knowledge and understanding (Conducting resea ¶ Making judgements (Design) The student evaluates smart vehicle technologies and writes a literature review article/report about developments in smart vehicle technology. The report has an introduction, a main text, a conclusion a discussion and references. The student specifies references according to a reference manual. The student determines the validity of referenced resources.	
Assessment criteria	The student will be assessed on the criteria (questions) mentioned on the evaluation form (next page). Furthermore, the paper will primarily be assessed on its: ¶ Clarity, for teaching staff as well as for other classmates ¶ Depth, showing and illustrating the complexity of the topic ¶ Critical thinking, showing and illustrating ú K Ŝ ă ú ditiĚaŜ view on the reviewed papers	
Information for each exam and modular exam		
Examinations	Exam code	M SV CS
		Week 2.6/4.6
	First examiner	Chris Huijboom / Frans Tillema / Marith Dieker / Bas Hetjes
	Exam method	Home taken exam: Article
	Permitted resources	Literature, Internet, Software
	Number of examiners	1
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1
	Compensation	No
	Review	Evaluation form week 2.10 / 4.10
Other information		
Required classroom	Regular classroom	

Capita Selecta

Evaluation and Awarding Marks

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Unit of Study (UoS) M SV MP	Smart Vehicles Minor Project
General Information	
Name of unit of study	Smart Vehicles Minor Project
Code for unit of study	M SV MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	5 EC / 140 hours
Study hours (contact hours)	64 contact hours and 4 contact hours presentation
Entry requirements	Systems Modelling
Objectives and instructional formats	
Professional task	Design, Implement, Test & Demonstrate a Smart Vehicle solution ƛ ƴ ű Ƙ Ŝ Ø Ŝ Ƙ ƛ Ŏ f Ŝ Ω ă Ŝ Ŏ ƨ ă è ă ű Ŝ Ƴ ø team.
(Professional) products	Detailed design/model of a technical smart vehicle solution Detailed implementation plans and deployment strategy plan Impact assessment report of new technology Report & Presentation + Demonstration of solution
General description	SVMP deals with (1) the design and implementation of new technologies for connected and automated transport, in the car bus, bike and other transport modes and (2) assessing the implementation of such technologies, keeping in mind their various capabilities, vehicle types, performance, functional desi security and privacy concerns, as well as the interplay between vehicle and its human users In a practical case given by one of the participating governments of private companies, students are stimulated to work together a real-life smart vehicle case, e.g.: ¶ Introduction of new sensors on cars and buses ¶ Introduction of automated logistics ¶ Introduction of AI and deep learning technologies ¶ Introduction of retro-fit ADAS on existing cars Students are challenged to model the problem on a functional level, model the technical solution on a functional and profound level and evaluate the impact on human behavior, people, impact, security, privacy and functional design.
Compulsory literature	-
Recommended literature	Project Management, A Practical Approach, Roel Grit, Noordhc Uitgevers, ISBN 9789001790929 Report Writing for readers with little time, Rien Elling, Bas Andeweg, Noordhoff Uitgevers, ISBN 9789001812591

Software and other materials	MATLAB Simulink, Phyton, Olimexino, Jetson and other materi that may be relevant for the project
Relationship	Units of study Smart Vehicles Units of study Systems Modelling
Compulsory participation	Yes
Activities and instructional formats	Research Work Forms: monitored group work, assignment
Examinations	
Final Qualifications	C1 Analysing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / learning outcomes	Dimensions of assessment: ¶ Applying knowledge and understanding (analysing and defining problems, design, testing, conducting research) ¶ Making judgements (analysing and defining problems, design, conducting research) ¶ Communication (managing work processes, collaboratio and communication) ¶ Learning skills (professional development) Learning outcomes: The student presents a clear justification of the project approac The student plans effectively. The student carries out a project based on a real-life problem in which model development and analysis as well as experimental validation are essential parts by applying knowledge and understanding and making judgements based on analysis and validation techniques. The student structures the working process in the engineering domain and is able to effectively communicate the core findings in a structured and convincing way. The student is able to systematically search for information, suc as e.g. models, and judge its relevance. The student communicates the project findings in a clear and structured manner with colleague, customers and the wider publi in oral and written forms. The content has been reviewed by pee and/or supervisor. The student reflects on his/her role in the project and on his/her professional development. The student designs and implements future smart vehicle technology.

Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. To determine the result of the minor project for each student: 10. A group mark will be defined by the examiners. 11. Peer review: each minor project group evaluates at least twice the contribution of the group members on content and collaboration. If the outcome of the first peer review is negative for the individual student, the student still has the opportunity to improve. If the result is negative again during the second peer review, the student will not receive a pass and therefore no final grade. 12. The individual mark is based on the group mark and the group contribution. The HAN supervisor can make use of the results of the peer review. Students should be aware of their own functioning within the project group, so should arrange peer feedback within their project group regularly.			
Information for each exam and modular exam				
Examinations	Exam code	M SV MP PP	M SV MP GC	M SV MP DP
		Week 2.1 / 4.1	Week 2.10 / 4.10	
	First examiner	Chris Huijboom / Frans Tillema / Marith Dieker / Bas Hetjes		
	Exam method	Project Plan	Group contribution	Documentation / presentation
	Permitted resources	Everything, but all results must be the student's own work		
	Number of examiners	1	2	
	Assessment	Pass	Pass	Mark
	Pass mark	V	Pass	55
	Minimal result	V	Pass	55
	Weight	0	0	1
	Reassessment	1 (week 2.4 /4.4)	1, week 4.11/4.12	
	Compensation	No	No	
	Review	Feedback 2.3 / 4.3	Feedback after presentation / evaluation form week 3.4/4.12	
Other information				
Required classroom	Regular classroom			

Project Smart Vehicles: Project Documentation and Presentation
Evaluation and Awarding Marks
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Module code M MAJP	Major Project
Degree program	Master Engineering Systems
Target Group	All students, mandatory
Coordinating lecturer	Content: Major Project Board Organization / procedures: Kea Bouwman
Professional Task	Not applicable
Professional Products	Project plan (project) Report/article and documentation (project) Presentation (progress and final)
Credits / Study load	30 EC / 840 hours
Relationship with and entry requirements concerning examinations	Unit of study: Major Project: Relationship: all modules Entry requirements: all requirements from the theoretical phase are met. Unit of study: Managing Work Processes: Relationship: all modules Entry requirements: after taking the first semester classes
General Description	The first part is Managing Work Processes: in this unit of stud students are four different subjects distinguished: a. Landscape: This deals largely with strategic issues, business trends, product trends and market issues b. Value chain: From sketch till scrap: the total value chain. Product lifecycle management. The production & supp chain and logistics principles. c. Working processes: Organization models. Simultaneou engineering. Lean production. Factory control, management theories. d. Quality models, tools and techniques: General Quality models as EFQM,ISO,TS, DFSS. Quality tools in the d process, and in the production process. The Toyota model (culture) The second part is the major project: the graduation project itself: this master graduation project is motivated by a real life problem, supplied by an engineering company. For a detailed description and the procedure see the Manual Major Project published on Onderwijs Online.
Final Qualifications	C1 Analyzing and defining problems C2 Design C3Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Units of study	Managing Work processes (2 EC) Major Project (28 EC)

Unit of Study (UoS) M MAJP MWP	Managing Work Processes
General Information	
Name of unit of study	Managing Work Processes
Code for unit of study	M MAJP MWP
Teaching Term	First en second semester
Credits/study load	2 EC / 56 h.
Study hours (contact hours)	36 contact hours and 4 hours presentation/defense
Entry requirements	After taking the first semester classes
Objectives and instructional formats	
Professional task	Not applicable
(Professional) products	Not applicable
General description	Four different modules are distinguished: e. Landscape: This deals largely with strategic issues, business trends, product trends and market issues f. Value chain: From sketch till scrap; the total value cha Product lifecycle management. The production & supp chain and logistics principles. g. Working processes: Organizat ion models. Simultaneous engineering. Lean production. Factory control, management theories. h. Quality models, tools and techniques: General Quality models as EFQM,ISO,TS, DFSS. Quality tools in the d process, and in the production process. The Toyota model (culture)
Compulsory literature	Lecturing material, papers and hand outs (Power Point, on Onderwijs Online),
Recommended literature	-
Required software	-
Relationship	Units of study Major Project Minor projects
Compulsory participation	Yes
Activities and instructional formats	Self-study, Working on assignments and exercises Work Forms: Lectures
Examinations	
Final Qualifications	C4 Managing work processes
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Applying knowledge and understanding (C4 Managing Work processes) - Making judgements (C4 Managing Work processes) The student has gained understanding of the dynamic world o the Engineering industry, the driving forces and policies, Qual

	and Business approach and working processes, and is able to apply it in given cases. The student can demonstrate awareness of system life cycle aspects. The student demonstrates knowledge of tools to obtain such breakdown structure. The student is able to apply specific management tools and models, amongst them business plans, implementation plans, project plans, Quality tools, organization measures.	
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. (next page)	
Information for each exam and modular exam		
Examinations	Exam code	M MAJP MWP OE
		First and second semester
	First examiner	Koen Lau / Harold van der Zee
	Exam method	Report and Presentation
	Permitted resources	Everything, but all results must be the ă ű dz Ř Ŝ y˝ ű Ω work
	Number of examiners	2
	Assessment	Mark
	Pass mark	55
	Minimal result	55
	Weight	1
	Reassessment	1 (oral based on reflection report)
	Compensation	No
	Review	Feedback after presentation, evaluation form week 1.4 / 3.4
Other information		
Required classroom	Regular classroom	

Managing Work Processes

Evaluation and Awarding Marks
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Unit of Study (UoS) M MAJP MP	Major Project
General Information	
Name of unit of study	Major Project
Code for unit of study	M MAJP MP
Teaching Term	Semester 1 / Semester 2
Credits/study load	28 EC / 784 h.
Study hours (contact hours)	-
Entry requirements	All requirements from the theoretical phase are met Entry requirements oral defense theoretical phase and all other fulfilments of the module major project.
Objectives and instructional formats	
Professional task	Not applicable depending on the subject
(Professional) products	proposal project plan, including requirements analysis report/article and documentation
General description	Graduation projects are motivated by real-life problems, supplied by engineering companies. A problem analysis will result in a problem solution, to be translated in terms such th conclusions can be drawn to what extent the problem has be solved and objectives fulfilled. A representative of a company is involved, to verify (1) whet the thesis result match the expectations of the company, and (2) whether the rated aspects of the major project are releva for the company. In this way, feedback is obtained on the professional requirements regarding the intended learning outcomes. The assignment is carried out by a single student, communicating with an external problem owner. The assignment results are presented and defended in a final presentation, and included in a project report. A detailed description complemented with a procedure can b found in the Manual Major Project Master Engineering Syste (#OO).
Compulsory literature	Lecturing material, papers and handouts (Power Point, on Onderwijs Online), w Ŝ LJ ƨ NJ ǘ ² NJ ƛ ǘ ƛ ƴ Ǝ Ŧ ƨ NJ NJ Ŝ l· Ř Ŝ NJ ă Uitgevers, ISBN 978-90-01-81259-1 Manual Major Project Master Engineering Systems
Recommended literature	-

Software and other materials	-
Relationship	Units of study Major Project Minor projects
Compulsory participation	Yes
Activities and instructional formats	Self-study, Work form: research
Examinations	
Final Qualifications	C1 Analyzing and defining problems C2 Design C3 Testing C4 Managing work processes C5 Conducting research C6 Communication and collaboration C7 Professional development
Assessment dimensions / Learning outcomes	Dimensions of assessment: - Knowledge and understanding (C1 Analyzing and defining problems, C5 Conducting Research) - Applying knowledge and understanding (C2 Design, C3 Testing, C4 Managing Work processes) - Making judgements (C1 Analyzing and defining problems, C2 Design, C4 Managing Work processes, C5 Conducting Research) - Communication (C1 Analyzing and defining problems, C6 Communication and Collaboration) - Professional Skills (Professional Development) *Analyzing and defining problems*: To be able to critically analyze the engineering problem through active communication with the problem owner, to translate this to a problem formulation, feasible solution approaches and scientifically valid conclusions and recommendations, to be communicated again to the problem owner. *Design*: To be able to systematically translate the engineering problem to a model at an abstract level, (i.e. reducing it to its essentials in terms of model and problem requirements) and validate results against the real life situation and problem formulation. Testing: To be able to systematically translate the engineering problem to a concrete level, and to validate results against the real life situation and problem formulation. *Managing work processes*: To be able to put engineering activities within the perspective of engineering company processes, including quality control principles. To be able to incorporate the economical (cost) and societal (safety, sustainability) consequences in the design or development process.

	*Conducting research*To have gained specialized scientific knowledge and skills in the field of engineering. *Communication and collaboration*Being able to work on a problem within a multidisciplinary context in an industrial environment. Being able to work on a problem in an international engineering context in an industrial environment *Professional development*To be able, through self-reflection, to improve oy Ŝ Ω ă ƨ ø y LJNJ ƨ Ŧ Ŝ ă ă ƛ ƨ y l· f
Assessment criteria	The student will be assessed on the criteria mentioned on the evaluation form. (next page)

Information for each exam and modular exam						
Examinations For detailed information Manual Major Project on Onderwijs Online	Exam code	M MAJP prop	M MAJP PP	M MAJP PE	M MAJP R	M MAJP D
		Proposal	Project plan	Progress evaluation	Report	Defense
	First examiner	MP board	HAN super-visor	HAN super-visor	MP board	MP board
	Exam method	Form	Report	Report	Report	oral
	Permitted resources	9 Ø Ŝ NJ è ú Ƙ ƛ y Ǝ Σ ō dz ű l· f f NJ Ŝ ă dz f				
	Number of examiners	2	1	1	2	2
	Assessment	Pass	Pass	Pass	Pass	Mark
	Pass mark	P	P	P	P	55
	Minimal result	P	P	P	P	55
	Weight	0	0	0	0	1
	Reassessment	1	1	1	1	0
	Compensation	-	-	-	-	-
	Review	Review:Feedback after presentation and defense. Evaluation Form within 2 working days				

Other information	
Required classroom	Regular classroom for presentation and defense

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Fill in this form (should fit on 2 pages) and send it to finalthesis.tm@han.nl

General information:

Student name:	
Mobile number:	
Email address:	
Study modules obtained: (for whichyou obtained 15 EC)	
Study modules currently following:	
Company name:	
Telephone number (company):	
Name of the company supervisor:	
E-mail address (company superviso	
Date:	
Major project start	Day ς month ς year
Date Defense:	Defense in <month>

Major project:

Project title:	
Background Provide a general description of the context of the problem and give tl reason for doing this research. Why should the problem be solved?	
Objective: What is the project trying to achieve? Formulate a concise and declarative statement that clarifies which problem should be solved. Note: activities are not objectives!	¶ X
Activities How are you going to analyze/solve the problem? Sum up the main activities, max. 4.	¶ X ¶ X ¶
Deliverables : Sum up the expected final result(s) / deliverables, what will you delive Next to your report, this could be one or more models (also state in wl form, like Matlab, GTPower, ..), software and/or hardware, manuals, e	¶ Thesis report and presentation ¶ X ¶ X
Demonstrating Master level	
Master level: The main goal of working on a Major Project is to demonstrate your master level. State how you intend to demonstrate your master level. Why do you think this subject can be helpful? Note: do not sum up yo study modules here. See the document *9tcd_level descriptors_full_text_council _8_march_06.pdf*, resp. the introduction and section 3.4	
The proposal is assessed in light of the following consideration: is the student able to show master level with this subject? Confirmation to students by mail / hand.	Yes/no

Evaluation Project plan

Student name :

The Major Project plan will be judged by the HAN supervisor
(after feedback from the company supervisor) on:

	V / NV (= sufficient/ not sufficient)	Motivation
Is the project plan structured according the format given on #OO)?		
Does the text indicate clearly that the research activities will lead methodically to the answering of the main research question?		
Does the text show a methodical approach and are methods and techniques chosen expertly?		
Are the requirements SMART and complete?		
Are the restrictions sufficiently described?		
Are the Activities and Products sufficien described?		
Are the objectives clear and correct?		
Is the English text understandable and sufficient level with respect to spelling and grammar?		
Time plan *Present and plausible?*		
V / NV For a pass all items should be sufficient	V / NV	

Date :

Signature HAN supervisor :

Progress evaluation

Student name :

Student number :

The Major Project progress will be judged by the HAN supervisor on:

	V / NV (= sufficient/ not sufficient)	Motivation
Is the major project report structured according to the format given on #OO?		
Does the text show a methodical approach and are methods and techniques chosen expertly?		
Is the table of contents present and sufficiently thought out?		
Chapter 2: Is the study of literature performed adequately and are the references known?		
Chapter 3: Has the student presented a clear justification for his/her approach, based on quantifiable choices?		
Is the English text understandable and c sufficient level with respect to spelling and grammar?		
Are the references correct according to one consistent standard?		
V / NV For a pass all items should be sufficient	V / NV	

Date :

Signature HAN supervisor :

Evaluation Major project report by HAN supervisor and major project board

Student name:
Student number:

Check on plagiarism	Percentage:	
Check pages	Body text > 40 pages	GO / NOGO
Decision GO / NO GO Decision based on check on plagiarism an evaluations of the major project and the HAN supervisor (next pages).	Motivation	

Date :
Name HAN supervisor: *Signature*

Name member major project board: *Signature*

In case you need additional explanation of the given motivation of the marks, contact your examiners.

The Major Project Report will be assessed by the member of the major project board on:

	V / NV (= sufficient/ not sufficient)	Motivation
Knowledge and understanding Has the student demonstrated relevant product knowledge and expertise in the field? 5 ƨ ű Ƙ Ŝ ă ű dz Ř Ŝ y˙ ű Ω ă NJ Ŝ ă dz depth? Have the central questions been answered? C1: Analyzing and defining problems C5:Conducting Research		
Applying knowledge and understanding Are the methods and techniques properly used a described? 5 ƨ ű Ƙ Ŝ ă ű dz Ř Ŝ y˙ ű Ω ă LJNJ ƨ Ƨ structured approach? C2: Design C3: Testing		
Making judgments Does the reportncorporate critical appraisal? C1: Analyzing and defining problems C2: Design C5: Conducting Research		
Communication Is the student able to present the content in a convincing way? Does the summary display the process of resear and is there a logical consistency between goals and results? Have the formal requirements for diagrams, table literary sources etc. been met? C1: Analyzing and defining problems		

The Major Project report/article will be judged by the HAN Supervisor on:

	V / NV (= sufficient/ not sufficient)	Motivation
Knowledge and understanding Are the goals of the report clear? Do the conclusions indicate if the goals are achieved and if not, do they indicate why not?		
Applying knowledge and understanding Are the results obtained in a logical way and ar they implementable? Do the recommendations describe their impact on the company?		
Making judgments Has the student presented a clear justification f his/her approach, based on quantifiable choice Has the student verified the design?		
Communication How is the language; are the texts well formulated? Does the report have a logical structure? Is the relation between goals and results described adequately?		
References Is the study of literature performed adequately and are the references known? and correct according to one consistent standard?		

Major Project : Evaluation and Awarding Marks

Name, first name
Topic
Company
Company representative

Evaluation (for criteria cf. back of this sheet)

The Master thesis / Major Project will be assessed by the examiners assisted by an external expert, the company coach and the main supervisor. The names of the examiners will be made known to the Masters candidate when work on the thesis ends (after the final GO).

	Mark	Motivation
Knowledge and understanding C1: Analyzing and defining problems C5: Conducting Research Weight factor 1 mark x 55		
Applying knowledge and understanding C2: Design C3: Testing C4: Managing work processes Weight factor 1 mark x 55		
Making judgments C1: Analyzing and defining problems C2: Design C4: Managing work processes C5: Conducting Research Weight factor 1 mark x 55		
Communication C1: Analyzing and defining problems C6: Communication and Collaboration Weight factor 1 mark x 55		
Learning Skills C7: Professional development Weight factor 1 mark x 55		
Mark total		

Date :
Signature examiner 1 :
Signature examiner 2 :

In case you disagree with your mark, first contact your examiner. When you still disagree with your examiner, contact the Exam board of the Master Engineering Systems for a final decision within 7 days.

Masters Degrees

Qualifications which signify the completion of the second cycle (Masters degrees) are awarded to students who have completed a program of study that enables them to show:

DUBLIN DESCRIPTOR	QUALIFICATION
Knowledge and understanding Provides a basis or opportunity for originality in developing or applying idea often in a research context.	*Analyzing and defining problems*: To be able to critically analyze the engineering problem through active communication with the problem owner, to translate th to a problem formulation, feasible solution approaches and scientifically valid conclusions and recommendations, to be communicated again to the problem owner. *Conducting research*: To have gained specialized scientific knowledge and skills the field of engineering.
Applying knowledge and understanding Through problem solving abilities applied in new or unfamiliar environments within broader (or multidisciplinary) context.	*Design*: To be able to systematically translate the engineering problem to a mo at an abstract level, (i.e. reducing it to its essentials in terms of model and prob requirements) and to validate results against the real life situation and problem formulation. Testing: To be able to systematically translate the engineering problem to a concrete level, and to validate results against the real life situation and proble formulation. *Managing work processes*: To be able to put engineering activities within the perspective of engineering company processes, including quality control principles To be able to incorporate the economical (cost) and societal (safety sustainability) consequences in the design or development process.
Making judgements Demonstrates the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete data.	*Conducting research*: To have gained specialized scientific knowledge and skills the field of engineering. *Analyzing and defining problems*: To be able to critically analyze the engineering problem through active communication with the problem owner, to translate this to a problem formulation, feasible solution approaches and scientifically valid conclusions and recommendations, to be communicated again to the problem owner. *Design:*