Curriculum bacheloropleiding Mechanical Engineering @ VU

Stand van zaken juli 2018 – Pieter Roos, kwartiermaker

APPENDIX 1: BACKGROUND INFORMATION

INTRODUCTION

The University of Twente (UT) and Vrije Universiteit (VU) are working on a bilocation Mechanical Engineering. It is specifically aimed at (i) attracting students from the Amsterdam area (Noord-Holland, Flevoland) and (ii) preparing them for enrolment in MSc-programmes at either UT or VU. Market research has shown the potential in these areas. The programme will be jointly taught by UT/VU-staff, with students spending time at both VU (≈75%) and UT (≈25%). Language is English. The first cohort, expected to be about 70 students, starts in *September 2019*. The distribution of teaching load UT/VU will gradually shift from 70/30 to 50/50.

As a guide for the programme's joint UT/VU identity, four themes have been defined: (i) smart manufacturing, (ii) energy transition & sustainability, (iii) maintenance and resilience, (iv) technology for healthcare. These themes come back in the curriculum.

Importantly, the programme will be a bilocation of UT's current ME-BSc programme. This has implications for the examination board and educational committee (see organizational structure below). To obtain permission for this bilocation under our existing CROHO, a CDHO-request has been filed to the Ministry of Education.

Since April 2018, various working groups have been active with representatives from UT and VU: (i) curriculum working group, (ii) logistics, (iii) business case, (iv) marketing & communication. In addition, there is a coordination group and a steering group (consisting of both rectors and deans of ET&VUbeta).

PROGRESS UPDATE

We inform you about the progress on the following aspects:

Curriculum. In essence, the rough design of the curriculum content has been completed (Appendix 2, further explained in appendix 3). It is largely based on the existing programme, maintaining content and final qualifications, while exploiting the strengths of TOM. Importantly, we follow VU's 8-8-4 semester structure (i.e. three blocks, rather than UT's 10 week quartile structure). Each of the four semesters in the first two years is connected to one of the themes, with projects running for the entire semester. Three novel elements, inspired by the current experience of the ME-teaching staff, are: (i) a general ME-intro in the first week of semester 1, (ii) dedicated mathematics line in support of the ME-content courses, (iii) continuous assessment at the end of each semester. Finally, standard elements are the minor (30 EC, enabling to certain MSc-programmes at UT/VU) and BSc-project. Regarding testing, this will be done by suitable clustering of programme elements (see Appendix 3 for a provisional scheme; this is work in progress).

Bilocation (fraction of students' time spent at VU and UT). We have also drafted a provisional schedule, to indicate the students' stays at UT, giving an estimate of 20-25% for the time fraction spent at UT and its campus. In brief, students will be at UT during the first week for the general ME-

intro. Further, every other week they will spend Thursday/Friday at UT for a mixture of practicals/workshops and some core lectures. When possible, these UT stays are planned around activities at UT's campus, such as *Bedrijvendagen* and *Batavierenrace* or social activities of the student's association *W.S.G. Isaac Newton*.

Facilities and staffing. It has been affirmed (by UT's executive board UT and ET's faculty board) that ET teaching facilities (workshops, including support staff) will be extended such as to meet the needs of the new BSc-programme, without affecting any of UT's existing programmes (ME and other). Also, new personnel (teaching and support staff) will be recruited at both UT and VU. Starting from now, as a first step, 6 UD's will be recruited by the faculty, in consultation with the various ET-departments. This is according to the business case (a UT-VU CvB's and faculty board's business plan), and will be expanded in due course. The above points (curriculum, bilocation) have been treated with these commitments in mind.

Organisational structure. As for now, it is foreseen that UT will deliver the Educational Director of the programme, that the tasks of the BSc-coordinator will be divided between UT and VU, and that student counseling will take place at VU. Further, there will be important roles for the examination board ME (formal check on learning goals and testing schemes), the student association Newton and the Educational Committee.

PLANNING

Finally, The following steps are planned for the upcoming period:

- OLC: July 6th OLC-WB will advise the Faculty board about their vision on the viability of the BSc programme UT-VU.
- FR: July 17th the Faculty Council will discuss the viability of the BSc programme UT-VU curriculum, also based on the OLC advise, as well as the staffing and facilities plan.
- UR: End of August the UR will discuss the viability of the BSc programme UT-VU, based on FR.
- Communication; Pending these decisions a marketing campaign will be designed per august 2018.
- Logistics; Pending these decisions the educational systems (for students and lecturers) will be prepared for this cooperation
- Examination Board ME: End 2018, the examination board will check on learning goals, which must be the same as those for the existing UT-programme. Testing plans to be discussed later.

APPENDIX 2: OVERVIEW OF CURRICULUM

CONTENT

B1 / SEM1	Block 1: Materials, Mech. & Manuf. I	12,0	Block 2: Materials, Mech. & Manuf. II	12,0	Block 3: Materials, Mech. & Manuf. III	6,0
Manufacturing	Math 1: Linear Algebra 1 (Lin.Sys.)	2,0	Math 2: Linear Algebra 2 (EVP)	1,0	Continuous Assessment 1	0,5
	Project 1a (incl intro design)	1,5	Project 1b (intro machine parts)	3,5	Project 1c	3,0
	Acad./Prof. Skills 1 (incl. intro to ME)	1,0			Acad./Prof. Skills 2	0,5
	Statics (incl. modpro of FEM)	4,0	Mechanics of Materials (incl. modpro of FEM)	4,0		
	Materials Science 1 (Metals)	2,0	Materials Science 1 (Metals)	2,0		
	Manufacturing 1 (rolling, deepdraw ing, quenchi	1,5	Manufacturing 1 (w orkshop, drilling, machining,	1,5	Manufacturing 1 (incl. w orkshop)	2,0

B1 / SEM2	Block 4: Energy Analysis	12,0	Block 5: Sustainable Energy	12,0	Block 6: Energy Systems	6,0
Energy Transition & Sustainability	Math 3: Calculus 1 (1 variable)	2,0	Math 4: Calculus 2 (multiple variables)	2,0	Continuous Assessment 2	0,5
	Project 2a: Energy production	2,0	Project 2b: Energy transmission / conversion	2,0	Project 2c: Energy Systems Engineering (BEC),	3,0
	Acad./Prof. Skills 3	1,0			Acad./Prof. Skills 4	0,5
	Thermodynamics 1 (Energy Cycles)	5,0	Thermodynamics 2 (pumps, hydraulics, pneum	2,5		
	Electricity & Magnetism (electromotor)	2,0	Sustainable Engineering Technology	2,5		
			Life Cycle Analysis (incl. practicum)	3,0	Intro to Product & System Design	2,0

B2 / SEM3	Block 7: Design for Maintenance	12,0	Block 8: Mechanical Integrity	12,0	Block 9: Mech. Integrity Monitoring	6,0
Maintenance	Math 5: Analysis 1 (ODEs)	2,0	Math 6: Analysis 2 (PDEs)	2,0	Continuous Assessment 3	0,5
	Project 3a: Design for maintenance	2,0	Project 3b: Condition monitoring	2,0	Project 3c: Condition Monitoring (incl.	3,0
	Acad./Prof. Skills 5	1,0	Acad/.Prof. Skills 6	0,5	Acad./Prof. Skills 7	0,5
	Dynamics 1	3,5	Dynamics 2	3,5	Experimental Methods (incl. Signal Analysis)	2,0
	Materials Science 2 (Plastic, Rubber, Composite	2,0	Tribology (bearings, contact, lubrication)	2,0		
	Manufacturing 2 (injection moulding, extrusion,	1,5	Manufacturing 2 (Machine parts)	2,0		

B2 / SEM4	Block 10: Fluid Flow	12,0	Block 11: Fluid Structure Interaction	12,0	Block 12: Factories of the Future	6,0
Technology for Healthcare	Math 7: Calculus 3 (Vector calculus)	2,0	Math 8: Statistics & Probability	2,0	Continuous Assessment 4	0,5
	Project 4a: Analysis of Blood / Lung device	2,0	Project 4b: Design of medical instrument	2,0	Project 4c: Factory design for product 4a/4b	3,0
	Acad./Prof. Skills 8	1,0	Acad./Prof. Skills 9	1,0	Acad./Prof. Skills 10	0,5
	Fluid Mechanics	3,5	Elasticity Theory + FEM	3,5		
	Heat Transfer	3,5	Design Engineering (incl. biomechanics)	3,5	Smart Factories & Production Management (six	2,0

B3 / SEM5	Block 13, 14 & 15: Minor	30,0
	Minor	30,0

B3 / SEM6	Block 16: Smart Manufacturing	12,0	Block 17: BSc Assignment	12,0	Block 18: BSc Assignment (cont'd)	6,0
	Math 9: Analysis 3 (Laplace & Fourier)	2,0			Continuous Assessment 5	1,0
	Project 5: Robotics & Mechatronics	3,0	BSc Assignment (1/2)	8,0	BSc Assignment (2/2)	4,0
	Acad./Prof. Skills 11	1,0	Research Skills 1	4,0	Research Skills 2	1,0
	Precision Engineering (incl. optics)	2,0				
	Control Engineering (incl. Simulink)	4,0				

COMPARISON: CURRENT VS NEW CURRICULUM

Course contents / teaching lines*	#EC (current curriculum)	#EC (new UT/VU-curr.)	ΔEC (new minus current)
Mathematics	16.0	17.0	+1.0
Materials Science	10.5	8.0	−2.5
Solid Mechanics	21.0	18.5	−2.5
Fluid Mechanics & Thermodyn.	14.0	17.0	+3.0
Design & Manufacturing	14.0	19.0	+5.0
Control & Precision Engineering	10.0	10.0	0.0
Projects	46.0	40.5	−5.5
Academic/Professional skills			0.0
Minor	30.0	30.0	0.0
Research (skills + BSc)	17.0	17.0	0.0
Continuous Assessment		3.0	+3.0
Technical drawing	1.5		−1.5
Total	**180.0**	**180.0**	**0.0**

**Colours as in new curriculum.*

APPENDIX 3: EXPLANATION PER SEMESTER

With a brief description of course content and a provisional test plan.

SEMESTER 1: THEME 'MANUFACTURING'

Block 1 (8 weeks, 12EC): Materials, Mechanics and Manufacturing I

Consists of the courses Math 1, Project 1a, Academic and Professional Skills 1, Statics, Materials Science 1 and Manufacturing 1.

course name	*description*	*load*	*testing*
Math 1	Linear algebra 1. The algebra of linear systems.	2EC	Math 1 + Statics together (6EC)
Statics	Statics + Modelling and Programming of FEM. Students learn how to do a simple FEM analysis with MATLAB.	4EC	
Project 1a	First part of Project 1 + an introduction to "How to design". There is a difference between a design and a *good* design.	1½EC	Intermediate*
Acad./Prof. Skills 1	Academic and professional skills + general introduction to Mechanical Engineering.	1EC	Intro to ME
Materials Science 1 (part 1)	Materials science about metals.	2EC	Intermediate*
Manufacturing 1 (part 1)	Manufacturing with rolling, deepdrawing, quenching, etc.	1½EC	Intermediate*

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 2 (8 weeks, 12EC): Materials, Mechanics and Manufacturing II

Consists of the courses Math 2, Project 1b + Machine parts, Mechanics of Materials, Material Science 1 and Manufacturing 1.

course	*description*	*load*	*Testing*
Math 2	Linear algebra 2. Eigenvalue problems	1EC	Math 2 + Mech. of Materials together (5EC)
Mechanics of Materials	Mechanics of Materials + Modelling and programming of FEM.	4EC	
Project 1b	Second part of Project 1 + Introduction to Machine parts.	3½EC	Intermediate*
Materials Science 1 (part 2)	Materials science about metals, continued.	2EC	Combined with block 1 (4EC)
Manufacturing 1 (part 2)	Manufacturing with drilling, machining, etc.	1½EC	Intermediate*

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 3 (4 weeks, 6EC): Materials, Mechanics and Manufacturing III

Consists of the courses Continuous Assessment 1, Project 1c, Academic and Professional Skills 2 and Manufacturing 1.

course	*description*	*load*	*testing*
Continuous Assessment 1	Continuous Assessment and recapitulation of lectures	½EC	Test
Project 1c	Third part of project 1	3EC	Final grade combined with projects 1ab (8½EC)
Acad./Prof. Skills 2	<< to be determined >>	½EC	
Manufacturing 1 (part 3)	Workshop practicals and related topics	2EC	Combined with blocks 1 & 2 (5EC)

SEMESTER 2: THEME 'ENERGY TRANSITION & SUSTAINABILITY'

Block 4: Energy analysis

Consists of the courses Math 3, Project 2a, Academic and Professional skills 3, Thermodynamics 1 and Electricity & Magnetism.

course	*description*	*load*	*testing*
Math 3	Calculus 1. Calculus of single variable.	2EC	Math 3 + Thermodynamics 1 together (7EC)
Thermodynamics 1	Thermodynamics 1 (Energy Cycles)	5EC	
Project 2a	Energy production project	2EC	Intermediate*
Acad./Prof. Skills 3	<< to be determined >>	1EC	Intermediate*
Electricity & Magnetism	A new course that introduces the student to electricity and magnetism. Among others the electromotor will be discussed.	2EC	Test

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 5: Sustainable Energy

Consists of the courses Math 4, Project 2b, Thermodynamics 2, Sustainable Energy Technology and Life Cycle Analysis.

course	*Description*	*load*	*testing*
Math 4	Calculus 2. Calculus of multiple variables.	2EC	Math 4 + Thermodynamics 2 + SET together (7EC)
Thermodynamics 2	Thermodynamics 2 (pumps, hydraulics, pneumatics).	2½EC	
Sustainable Engineering Technology	This new course will teach the student more about sustainable energy technologies. It introduces the student to de basis of the SET master.	2½EC	
Project 2b	Energy transmission and conversion, combined with project 2a.	2EC	Intermediate*
Life Cycle Analysis	The concept of life cycle analysis will be taught + practicals with make LCAs.	3EC	See block 6

**Intermediate to be integrated with other subgrades later this semester.*

Block 6: Energy Systems

Consists of the courses Continuous Assessment 2, Project 2c, Academic and Professional skills 4 and Introduction to Product and System Design.

course	*description*	*load*	*testing*
Continuous Assessment 2	Continuous Assessment and recapitulation of lectures Semester 1 and 2.	½EC	Test
Project 2c	Project about energy systems engineering (BEC).	3EC	Projects 2abc + LCA + Acad./Prof. Skills 3&4 together (11½EC)
Acad./Prof. Skills 4	<< to be determined >>	½EC	
Introduction to Product and Systems Design	Systems engineering (old name of this course)	2EC	Test

SEMESTER 3: THEME 'MAINTENANCE'

Block 7: Design for Maintenance

Consists of the courses Math 5, Project 3a, Academic and Professional skills 5, Dynamics 1, Material Science 2 and Manufacturing 2.

course name	*description*	*load*	*testing*
Math 5	Analysis 1. Ordinary differential equations	2EC	Math 5 + Dynamics 1 together (5½EC)
Dynamics 1	Dynamics 1	3½EC	
Project 3a	Project on Design for maintenance	2EC	Intermediate*
Acad./Prof. Skills 5	<< to be determined >>	1EC	Intermediate*
Materials Science 2	Material science about plastics, rubber, composites, etc.	2EC	Materials Science 2 and Manufacturing 2 together (3½EC)
Manufacturing 2	Manufacturing with injection moulding, extrusion, etc.	1½EC	

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 8: Mechanical Integrity

Consists of the courses Math 6, Project 3b, Academic and Professional Skills 6, Dynamics 2, Tribology and Manufacturing 2.

course name	*description*	*load*	*testing*
Math 6	Analysis 2. Partial differential equations	2EC	Math 6 + Dynamics 2 together (5½EC)
Dynamics 2	Dynamics 2	3½EC	
Project 3b	Project 3a continued including condition monitoring	2EC	Intermediate*
Acad./Prof. Skills 6	<< to be determined >>	½EC	Intermediate*
Tribology	Tribology with bearings, contacts and lubrication	2EC	Tribology and Manufacturing 2 together (4EC)
Manufacturing 2 (Machine parts)	Manufacturing 2 (Machine parts)	2EC	

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 9: Mechanical Integrity Monitoring

Consists of the courses Continuous Assessment 3, Project 3c, Academic and Professional Skills 7 and Experimental Methods.

course	*description*	*load*	*testing*
Continuous Assessment 3	Continuous Assessment and recapitulation of lectures Semester 1, 2 and 3.	½EC	Test
Project 3c	Project 3b continued including Condition Monitoring.	3EC	Projects 3abc + Acad./Prof. Skills 5&6&7 together (9EC)
Acad./Prof. Skills 4	<< to be determined >>	½EC	
Experimental Methods	New course about experimental methods. The students learn how to do proper experiments and measurement on academic level. Including signal analysis.	2EC	Test

SEMESTER 4: THEME 'TECHNOLOGY FOR HEALTHCARE'

Block 10: Fluid Flow

Consists of the courses Math 7, Project 4a, Academic and Professional skills 8, Fluid Mechanics and Heat Transfer.

course name	*description*	*load*	*testing*
Math 7	Calculus 3. Vector calculus.	2EC	Math 7 + Fluid Mechanics together (5½EC)
Fluid Mechanics	Fluid Mechanics.	3½EC	
Project 4a	Project about analysis of blood/lung device.	2EC	Intermediate*
Acad./Prof. Skills 8	<< to be determined >>	1EC	Intermediate*
Heat Transfer	Heat Transfer.	3½EC	Test

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 11: Fluid Structure Interaction

Consists of the courses Math 8, Project 4b, Academic and Professional skills 9, Elasticity Theory + FEM and Design Engineering.

course name	*description*	*load*	*testing*
Math 8	Statistics and Probability theory	2EC	<< see block 12 >>
Elasticity Theory + FEM	Elasticity theory + Finite Element Method	3½EC	Test
Project 4b	Project 4 continued including design of a medical instrument.	2EC	Intermediate*
Acad./Prof. Skills 9	<< to be determined >>	1EC	Intermediate*
Design Engineering	A new course that teaches students how to properly design something (also see project 1a in Block 1). Includes biomechanics.	3½EC	Test

**Intermediate tests to be integrated with other subgrades later this semester.*

Block 12: Factories of the Future

Consists of the courses Continuous Assessment 4, Project 4c, Academic and Professional skills 10 and Smart Factories & Production Management.

course	*description*	*load*	*Testing*
Continuous Assessment 4	Continuous Assessment and recapitulation of lectures Semester 1, 2, 3 and 4.	½EC	Test
Project 4c	Project 4 continued with factory design for the product developed in project parts 4ab.	3EC	Projects 4abc + Acad./Prof. Skills 8&9&10 together (9½EC)
Acad./Prof. Skills 10	<< to be determined >>	½EC	
Smart Factories & Production Management	This course consists of production management (how to design and supply a factory, how much stock should I keep, lean Manufacturing, Six Sigma) and new material about Smart Factories.	2EC	Math 8 + Smart Factories & Prod. M. together (4EC)

SEMESTER 5: MINOR

Blocks 13, 14 and 15: Minor space

Students are encouraged to take minors from UT/VU which prepare for subsequent MSc-programmes at these universities.

SEMESTER 6: 'SMART MANUFACTURING', GRADUATION

Block 16: Smart Manufacturing

Consists of the courses Math 9, Project 5, Academic and Professional skills 11, Precision Engineering and Control Engineering.

course name	*description*	*load*	*testing*
Math 9	Analysis 3, including Laplace and Fourier transforms.	2EC	Math 9 + Control Engineering together (6EC)
Control Engineering	The student learns how to control a (mechanical) system (including Simulink).	4EC	
Project 5	Project about robotics and mechatronics.	3EC	Project 5 + Acad./Prof. Skills 11 + Precision Engrg. together (6EC)
Acad./Prof. Skills 11	<< to be determined >>	1EC	
Precision Engineering	Student learns how to design a precision device. The student also gets an introduction into optics.	2EC	

Block 17: Bachelor assignment

Consists of the Bachelor Assignment and Research Skills 1.

course name	*description*	*load*	*testing*
Bachelor Assignment	Bachelor Assignment (start)	8EC	<< see block 18 >>
Research Skills 1	<< to be determined >>	4EC	

Block 18: Bachelor assignment (continued)

Consists of the Bachelor Assignment, Research Skills 2 and Continuous Assessment 5.

course name	*description*	*load*	*testing*
Continuous Assessment 5	Continuous Assessment and recapitulation of lectures Semester 1, 2, 3, 4 and 6.	1EC	Test
Bachelor Assignment	Bachelor Assignment (continued)	4EC	Bachelor Assignment + Research Skills 1&2 together (17EC)
Research Skills 2	<< to be determined >>	1EC	