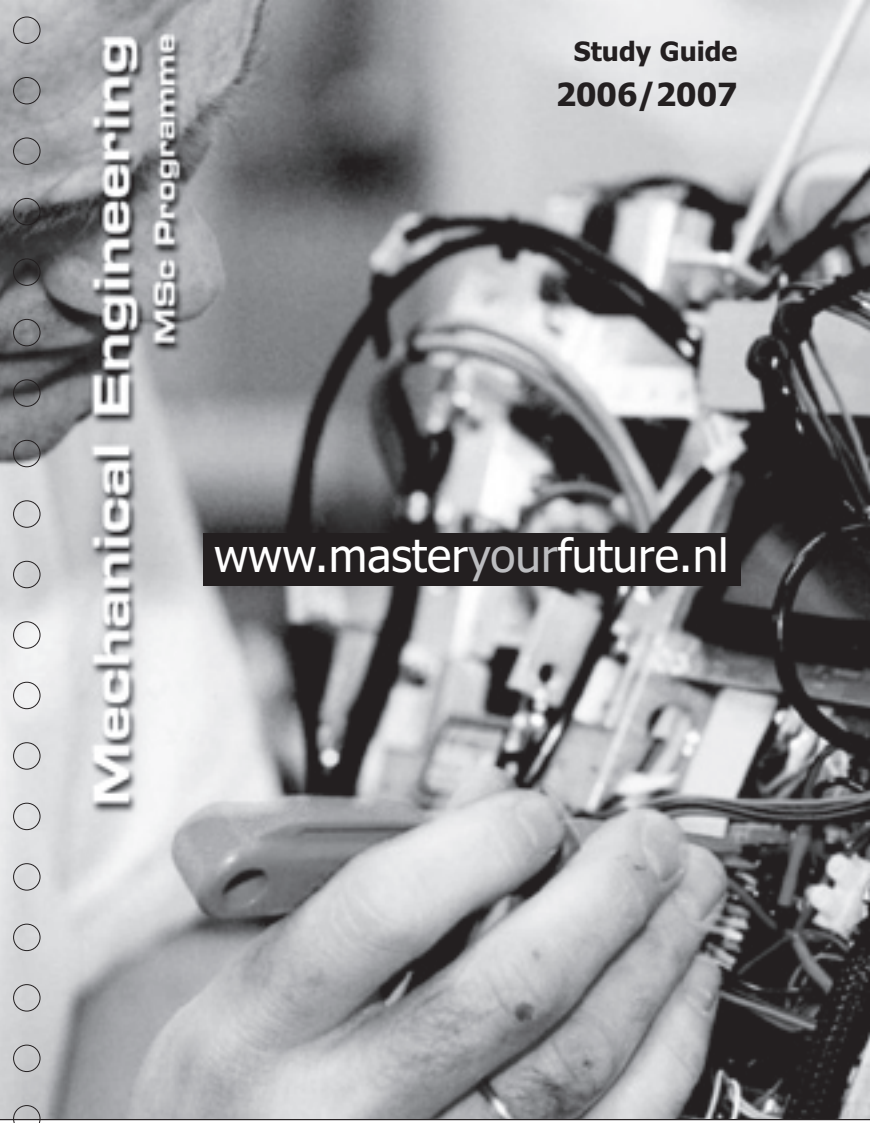
Mechanical Engineering

MSc Programme

Study Guide
2006/2007



TU Delft

Delft University of Technology

Disclaimer

This guide has been compiled with the utmost care by the Faculty. There are a number of items about which further information will only become available after this guide has been published. For this reason the information published in this guide can be subject to change. Changes, additional information and more detailed course descriptions are available on Blackboard: blackboard.tudelft.nl and/or on the SIS website www.tudelft.nl/sis.

Table of contents

Personal details

name

address

postal code / city

telephone

mobile

e-mail

NOTIFY IN CASE OF EMERGENCY:

name

address

postal code / city

country

telephone mobile

MEDICAL INFORMATION:

medications

allergies

passport no

blood group

organ donor: yes / no; card no:

If found, please return this student guide or contact the owner.

Faculty Preface

The Mechanical Engineering Guide gives all information about the master's programme Mechanical Engineering students need to plan their study effectively. This year, detailed course schedules are only available on the website: campus.3mE.TUDelft.
The programme offers six specialisations:

- Bio-Mechanical Design
- Control Engineering
- Production, Mechatronics and Microsystems
- Solid and Fluid Mechanics
- Sustainable Process and Energy Technology
- Transportation Engineering

The different focus areas within these specialisations offer the students a variety of topics, all covering extremely interesting applications and fundamental aspects of Mechanical Engineering.

The editors of this guide wish all students a great academic year.

Prof.dr.ir. Peter A. Wieringa
Director of Education faculty 3mE

Academic calendar 2006/2007

Fall semester

4/9/06			15.00 Aula: opening academic year
4/09	-	20/10	scheduled teaching activities
23/10	-	3/11	no scheduled activities/ examinations/ scheduled teaching activities
6/11	-	22/12	scheduled teaching activities
27/12	-	5/1/07	Christmas vacation
8/1/07	-	12/1	no scheduled activities
15/1	-	2/2	examinations

Spring semester

5/2/07	-	23/3	scheduled teaching activities
26/3	-	5/4 (do)	no scheduled activities/ examinations/ scheduled teaching activities
10/4 (Tue)	-	27/4	scheduled teaching activities
6/4			Good Friday
9/4			Easter Monday
30/4	-	4/5	no scheduled activities (May vacation)
7/5	-	8/6	scheduled teaching activities
17/5, 18/5			Ascension day
26/5			no scheduled activities
28/5			Whit Sunday
11/6	-	15/6	no scheduled activities
18/6	-	6/7	examinations
20/8	-	31/8	examinations/repeats

Note: examinations are usually called 'tentamens' in Dutch. Formally an 'examen' in Dutch is the degree audit taking place at the end of a programme phase such as a Propaedeuse (end of first year), a Bachelor or a Master phase. These 'examens' are formalities in the Dutch university system. There are no end-of-year examinations!

Class hours for Delft University of Technology

Period	Time
1.	08.45 – 09.30
2.	09.45 – 10.30
3.	10.45 – 11.30
4.	11.45 – 12.30
5.	13.45 – 14.30
6.	14.45 – 15.30
7.	15.45 – 16.30
8.	16.45 – 17.30

TU Delft – University Facts and Mission

Founded in 1862, Delft University of Technology is the oldest, largest, and most comprehensive university of technology in the Netherlands. With over 13.000 students and 2100 scientists (including 200 professors), it is an establishment of both national importance and significant international standing. Renowned for its high standard of education and research, the University collaborates with other educational establishments and research institutes, both in the Netherlands and overseas. It also enjoys partnerships with governments, branch organisations, numerous consultancies, the industry, and companies from the small and medium business sectors. Delft University of Technology has eight faculties offering a host of engineering programmes, many of them unique in the Netherlands.
Working together with other educational establishments, various research institutes, international business partners and the industry, TU Delft aims to provide students with all the necessary tools for a successful career: an excellent education, relevant, practical experience, and the broadest possible knowledge base. Detailed information can be obtained from the website www.tudelft.nl

International Office

This office will be your first point of contact at the University. The International Office staff handles the application procedure, financial and housing matters, and the distribution of student ID cards. The International Office comprises the central TU Delft Student Registration Office, which registers you as a student when you are admitted to TU Delft.

The Student Facility Centre publishes a Guide to Services, which is available from Julianalaan 134 or can be obtained by phoning +31 (0)15 27 88012 or emailing sfc@tudelft.nl

TU Delft International Office
PO Box 5
2600 AA Delft

The Netherlands
Tel: +31 (0) 15 27 88012
Fax: +31 (0) 15 27 85690
E-mail: admission@tudelft.nl
Website: www.studyat.tudelft.nl

Visiting address:
Julianalaan 134
2628 BL Delft
The Netherlands

Around October 2006 the International Office and the Student Facility Centre will move to a new location at the Mekelweg.
Postal address:
Jaffalaan 9A
2628 BX Delft
Visitors' entrance at the Mekelweg

Service desk

The Service Desk provides you with your transcripts, timetables and exam dates, and it posts the exam results. Here you submit forms, you inform them of recently acquired marks, and a change of address. The Service Desk tracks student progress, i.e. the number of credits and marks you obtain and any group work done in a semester and/or academic year.
More information is available on servicepunt.tudelft.nl
The Service Desk is open Monday to Friday, from 5.00 to 17.00 hours.

Blackboard

Blackboard provides you with the most recent information about your courses. It is a commercial E-learning medium that serves as a virtual notice board for announcements, timetables, presentation of programme materials, practice materials, exercises and solutions as well as interesting links. You can enter the system using the 'Preview' button in the login screen, but to access all information, you need a personal login ID.
Website: blackboard.tudelft.nl
Request assistance through Blackboard-support@tudelft.nl

Schedules

For up-to-date schedules, go to blackboard.tudelft.nl or the campus website of your faculty.

TU Delft Library

The TU Delft Library consists of a central branch located behind the Aula and seven faculty branches in a number of locations. The collection, the excellent study facilities, the modern PCs and the package of services in each library are designed to provide you with optimal access to relevant science and technology literature. On the Library's website, www.library.tudelft.nl, you can find all information you need if you want to visit a library or use one of the services of the TU Delft Library.

Customer Services TU Delft Library:
Tel: +31 (0)15 27 85678
Fax: +31 (0)15 27 85706
E-mail: library@tudelft.nl
Website: www.library.tudelft.nl

Opening times central branch:

	Tuition period	Examination period	Summer holiday
Monday - Thursday	9.00 - 22.00	9.00 - 24.00	9.00 - 17.00
Friday	9.00 - 18.00	9.00 - 22.00	9.00 - 17.00
Saturday - Sunday	10.00 - 18.00	10.00 - 22.00	closed

The opening times of the faculty libraries can be found at www.library.tudelft.nl under 'locations'.

Opening times central information desk:

Monday - Thursday	9.00 - 19.00
Friday	9.00 - 17.00
Saturday	10.00 - 13.00
Sunday	closed

Every first Monday of the month: 11.00 - 19.00

Regulations

There are a number of formal regulations for the faculty organization, the programmes and their execution. These are:

- The Faculty Regulations
- The Course and Examination Regulations ('Onderwijs- en Examenreglement').
- (Per programme) The Execution Regulations of the Education and Examination Regulations ('Uitvoeringsregeling').
- The Rules and Guidelines of the Board of Examiners ('Regels en Richtlijnen van de Examen Commissie').
- The Student Charter ('Studentenstatuut')

These regulations are published yearly on the web, see the Blackboard community of the programme involved. In case of doubt, your Director of Education or your Study Adviser will be glad to inform and advise you.

EUROPEAN STUDENT UNION (AEGEE)
AEGEE is the European students' association, represented in 271 cities in 40 countries. Over 17,000 member students are actively involved in travelling, participating in fun and pleasure events and conferences on topics that concern you. There are a lot of possibilities to travel to other places in Europe, meet new people and make friends everywhere! In every city there is an independent local association such as AEGEE-Delft.
Check out the website: www.aegee-delft.nl

TU DELFT'S STUDENT UNION (VSSD)
The purpose of the VSSD is to safeguard the interests of all students studying at Delft University of Technology. The Union mainly focuses on areas such as education, income, legal status and housing. The VSSD is a member of the National Student Union (LSVB) and of the ISO (a national student body). As well as representing the collective interest of students, the VSSD also provides support and services to individual students by helping them with financial, housing, study and other problems, and through the publication and sale of reasonably priced textbooks.

Office:
Leeghwaterstraat 42 (building 45 on map)
Tel: +31 (0)15 27 82050
Fax: +31 (0)15 27 87585
E-mail: balie@vssd.nl
Website: www.vssd.nl
Opening hours: Monday to Thursday 08.30-17.00, Friday 08.30-13.00

Shop:
Leeghwaterstraat 42,
Tel: +31 (0)15 27 84125
Fax: +31 (0)15 27 81421
E-mail: winkel@vssd.nl
Opening hours: Monday to Friday between 10.30-14.00 and 15.00-17.00

USEFUL WEB ADDRESSES:
www.tudelft.nl (general information about Delft University, history, programmes, research, etc.)

www.studyat.tudelft.nl (information about all BSc and MSc programmes offered by Delft University of Technology, information about the requirements, how to apply, costs, funding, insurance, housing, medical and pastoral care, facilities for special needs students etc.)

www.ideeenlijnOS.tudelft.nl (You can post your suggestions and comments with a view to improving the services provided by O&S on this website. You can also use this address for complaints, of course.)

www.snc.tudelft.nl (TU Delft Sports & Cultural Centre)

www.dsdelft.nl/centrum (information about Delft)

www.denhaag.org (for activities in the nearby city of Den Haag)

www.uitaandemaas.nl (activities in Rotterdam)

www.amsterdam.nl (activities, news, public transport in and around Amsterdam)

ADDRESSES:
Delft University of Technology (TU Delft)
Visiting address:
Julianalaan 134
2628 BL Delft
The Netherlands

Postal address:
PO Box 5
2600 AA Delft
The Netherlands
Tel: +31 (0)15 27 89111
Fax: +31 (0)15 27 86522
E-mail (for questions): voorlichting@tudelft.nl
(For information about the city of Delft, please see www.delft.nl)

Education and Student Affairs
Tel: +31 (0)15 27 84670
E-mail: OS@tudelft.nl
Website: www.OS.tudelft.nl

- Central Student Administration (CSA)
PO Box 5
2600 AA Delft
Tel: +31 (0)15 27 84249
E-mail: msc2@tudelft.nl
Website: www.csa.tudelft.nl/
Office hours: 8.30-17.00

- International Office
Julianalaan 134
2628 BL Delft
Tel: +31 (0)15 27 88012
E-mail: msc2@tudelft.nl
Website: www.studyat.tudelft.nl

- Student Facility Centre (SFC)
Study Advisers:
Opening hours: Monday to Friday 09.00-17.00.
Student Psychologists:
Tuesday and Thursday 11.30-12.30
Julianalaan 134
2628 BL Delft
Tel: +31 (0)15 27 88012
E-mail: sfc@tudelft.nl

Around October 2006, Education and Student Affairs (i.e. CSA, International Office, Student Facility Centre) will move to a new location on the Mekelweg.
Postal address:
Jaffalaan 9A
2628 BX Delft
Visitors' entrance at the Mekelweg

Sports & Cultural Centre
Mekelweg 8-10
2628 CD Delft
Tel: +31 (0)15 27 82443
E-mail: sportcentrum@tudelft.nl
Website: www.snc.tudelft.nl
Monday to Friday: 08.30-23.30; Saturday and Sunday: 08.30-19.00.

Student Health Care: SGZ
Surinamestraat 4
2612 EA Delft
To make an appointment, call +31 (0)15 212 1507
Monday to Friday 8.30-12.15

Stichting DUWO
(Delft Housing Agency)
Marlotlaan 5
2614 GV Delft
Tel: +31 (0)15 219 2200
E-mail: info@duwo.nl
Website: www.duwo.nl
Office hours: Monday to Friday 08.30-17.00.

Student Restaurants in Delft
- University main cafeteria, Aula, Mekelweg 5
- SnC Café, Mekelweg 8
- Sint Jansbrug, Oude Delft 50-52
- Koornbeurs, Voldersgracht 1
- Alcuin, Oude Delft 123
- CSR, Oude Delft 9
- De Bolk, Buitenwatersloot 1-3
- Novum, Verwersdijk 102-104

Map of TU Delft

A	Ezelsveldlaan 61	Delft Technology Museum
2	Mijnbouwplein 11	Used by various external parties
3	Mijnbouwstraat 120	Applied Earth Sciences
5	Julianalaan 67	Biotechnology (Kluyver Lab)
6	Poortlandplein 6	Botanic Gardens
8	Julianalaan 132-134	TU Delft Student Facility Centre
9	Zuidplantsoen 2	MultiMedia Services (MMS)
10	Zuidplantsoen 6	Student Council
11	Zuidplantsoen 8	Real Estate and Facility Management
12	Julianalaan 136	Delft ChemTech
15	Prins Bernhardlaan 6	Kramers Laboratorium voor Fysische Technologie
17	i-WEB:	Vehicle for Research, Education and Design
19	Mekelweg 3	Stud: student employment agency
20	Mekelweg 5	Aula Congress Centre
21	Prometheusplein 1	TU Delft Central Library
22	Lorentzweg 1	Faculty of Applied Sciences
23	Stevinweg 1	Faculty of Civil Engineering and Geosciences
24	Berlageweg 1	Faculty of Architecture, Urbanism and Building Sciences
30	Jaffalaan 9	OTB Research Institute
31	Jaffalaan 5	Faculty of Technology, Policy and Management
32	Landbergstraat 15	Faculty of Industrial Design Engineering
33	Landberghstraat 19	Composites Laboratory INHOLLAND/TU Delft
34	Mekelweg 2	Faculty of Mechanical, Maritime and Materials Engineering
34a	Cornelis Drebbelweg 9	Executive Board
35	Cornelis Drebbelweg 5	Examination rooms
36	Mekelweg 4 + 6	Faculty of Electrical Engineering, Mathematics and Computer Science
37	Mekelweg 8	TU Delft Sports Centre
38	Mekelweg 10	TU Delft Cultural Centre
40	Rotterdamseweg 137	Materials Engineering
43	Leeghwaterstraat 36	Cogeneration plant
44	Rotterdamseweg 145	Yes!Delft/Technostarters
45	Leeghwaterstraat 42	VSSD & Low Speed Wind Laboratory
46	Leeghwaterstraat 44	Process and Energy Laboratory (API)
50	Mekelweg 15	Radiation Radionuclides & Reactors (R3) / Reactor Institute Delft (RID)
61	Kluyverweg 3	Faculty of Aerospace Engineering: Vliegtuighal
62	Kluyverweg 1	Faculty of Aerospace Engineering
63	Anthony Fokkerweg 1	Faculty of Aerospace Engineering: SIMONA
64	Kluyverweg 2	High Speed Wind Laboratory
65	Kluyverweg 4 + 6	Delft Transport Centre (DTC)

1.1 OBJECTIVE

The objective of the Master's programme Mechanical Engineering is to educate graduates in Mechanical Engineering to undertake careers as scientists or engineers at an advanced professional level. The level corresponds to the scientific and technological borders of a specific discipline. The graduates are capable of:

- identifying, defining and analysing problems, to the solution of which Materials Science and Engineering principles and techniques can contribute
- developing and producing a sound solution to the problem
- presenting these solutions effectively

The Master's graduate of Materials Science and Engineering meets, to a sufficient level, the following qualifications:

1. Broad and profound knowledge of engineering sciences (mathematics, physics and chemistry) and the capability of applying this knowledge in the Materials Science and Engineering discipline at an advanced level.
2. Broad and profound scientific and technical knowledge of the Materials Science and Engineering discipline and the skills to use this knowledge effectively. The discipline is mastered at different levels of abstraction, including a reflective understanding of its structure and relations to other fields, and reaching the forefront of scientific or industrial research and development on numerous occasions. The knowledge is the basis for innovative contributions to the discipline in the form of new knowledge about materials or development of new materials.
3. Thorough knowledge of paradigms, methods and tools as well as the skills to actively apply this knowledge to analysing, modelling, simulating, designing and performing research with respect to problems related to Materials Science and Engineering.
4. Capability of independently solving technological problems in a systematic way involving problem analysis, formulating sub-problems and providing innovative technical solutions, also in new and unfamiliar situations. This includes a professional attitude towards identifying and acquiring any expertise lacking, monitoring and critically evaluating existing knowledge, planning and executing research, adapting to changing circumstances, and integrating new knowledge with appreciation of its ambiguity, incompleteness and limitations.
5. Capability of working both independently and in multidisciplinary teams, interacting effectively with specialists and taking initiatives where necessary.
6. Capability of effectively communicating (including presenting and reporting as well as contributing significantly to a scientific paper) about one's work such as solutions to problems, conclusions, knowledge and considerations, to both professionals and a non-specialised public in the English language.
7. Capability of evaluating and assessing the technological, ethical and societal impact of one's work, and to take responsibility with regard to sustainability, economy and social welfare.
8. Attitude to independently maintain professional competence through life-long learning.

1.2 EDUCATIONAL CONCEPT AND ASSESSMENT

The Master's programme Materials Science and Engineering covers two years of study, each with a study load of 60 EC (European credits). The total programme involves 120 EC and comprises cursory modules, assignments and a Master's thesis project:

Cursory modules (50 - 70 EC)

These are offered as lectures given simultaneously to all students taking the module. Most cursory modules are assessed by means of a written examination. In some cases however assessment takes place by means of an oral examination.

- Compulsory courses specialisation (at least 20 EC)
- Compulsory courses focus area
- Elective courses (at least 15 EC)

These courses should include at least 6 EC worth of social courses and 9 EC of fundamental engineering courses.

Assignments (50-70 EC)

This form is used for projects, practicals and a possible internship in industry or a research institute. Assignments are offered to individual students or small groups of students and are assessed by a report and / or a presentation.

The requirements for assignments and lecture courses are specified in section 1.5 for each specialisation. Assignments may involve:

- An internship in industry or a project defined in consultation with an external party (industry, research institute, etc.) of 15 EC. This may be combined with the MSc thesis if performed in cooperation with and at the location of an external party.
- MSc thesis (30 - 60 EC)
- Other individual or group assignments.

MSc thesis project

Each individual student prepares a thesis as a report of his/her research project. The thesis work is evaluated through an oral presentation by the candidate and an oral examination before an MSc examination committee. This committee is composed of at least three scientific staff members, including the thesis supervisor. The examination committee may also include external examiners from research institutes or from industrial partners.

1.3 STUDY PROGRAMME AND GENERAL STRUCTURE

Mechanical Engineering offers an MSc course of two years. Each course year is divided into two semesters and each semester consists of two periods. A period includes seven weeks of lectures, followed by two or three examination weeks.

For those subjects for which written examinations are held, the student will get at least one opportunity per year to do a resit. Resits are generally held in the first period after the regular period for a certain examination. Resits for the examinations held in period 2B are scheduled for the second half of August.

The study load of a course is expressed in European Credits. This is a result of the European Credit Transfer System (ECTS), which encourages acknowledgement of study results between higher education institutions within the European Union. The study load for one educational year is 60 EC. These ECs give an indication of the weight of a certain part of the course. One EC involves approximately 28 hours of study. These 28 hours include all time spent on the course: lectures, self-education, internship, practicals, examinations, etc.

1.4 ADMISSION TO THE PROGRAMME

There are several ways to be admitted to the MSc programme Mechanical Engineering. Usually the MSc programme is a continuation of an academic BSc programme (1.4.1). However the Master's programme can also be entered after completing a Bachelor's programme of a Dutch polytechnic institute (1.4.2) or the "Royal Netherlands Naval College" (KIM, 1.4.3). Admission to the MSc programme Mechanical Engineering is described in the following three subsections.Contact and information: Teunie Eden, Jaap van der Zanden or Ewoud van Luik.

1.4.1 ACADEMIC BACHELOR'S DEGREE MECHANICAL ENGINEERING (DUT, TUE, UT AND IDEA LEAGUE)

Candidates holding a BSc degree in Mechanical Engineering awarded by a Dutch University of Technology (Delft, Eindhoven or Twente) or a member institution of the IDEA League (ETH Zürich, Imperial College London or Technische Universität Aachen) may enter the MSc programme unconditionally.

A student who has yet to complete the BSc may be permitted by the Board of Examiners to take examinations from the MSc programme. The prerequisites for such conditional admission are that the student has passed the first year of the BSc and has already obtained at least 100 EC in the second and third-year programme. Final admission is granted after completing the BSc.

TU Delft bachelor's degree in Marine Technology (MT), Civil Engineering (CI), Aerospace Engineering(AE), Industrial Design Engineering (IDE), Applied Physics (AP), or Chemical Engineering (CE)

Students with one of these degrees can enter the MSc programme without selection. In order to enter the MSc programme, additional courses have to be followed. These are courses of the BSc programme Marine Technology worth 45 EC in total or less. 15 EC of these additional courses will be part of the elective courses and at most 30 EC will be part of an additional programme. The total programme will amount to: 120 + max 30 = 150 EC at most. These additional requirements will ensure that the student has at least an entrance level comparable to the second year of the Marine

Technology BSc programme. The lecturer of the focus area can also require that in addition the student takes a number of third year courses of the BSc programme.
Courses are given in Dutch. A summary of additional courses and requirements is given below, in Dutch.

The additional courses are the following:

Course code	Course name	EC	AP	AE	CI	IDE	MT	CE
et3026wb	Elektrische aandrijvingen	3	x		x			x
wb1114	Statica	3	x					x
wb1115	Sterkteleer 1	4	x					x
wb1116	Dynamica A	4						x
wb1217	Sterkteleer 2	3	x			x		x
wb1218	Niet lineaire mechanica	2	x			x		x
wb1216	Dynamica 2	3	x		x	x		x
wb1225	Stromingsleer	3				x		
wb1224	Thermodynamica 2	3	x		x	x	x	
wb1321	Warmte en stofoverdracht	3		x	x	x	x	x
wb2104	Inleiding modelvorming en regeltechniek	3			x			
wb2207	Regeltechniek	3	x	x	x	x	x	x
wb3101	Ontwerpen wtk. systemen 1	4	x	x	x		x	x
wb3201	Ontwerpen werktuigk. systemen 2	3	x	x	x	x	x	x
wb4100	Thermodynamica 1	3			x	x		
wb5104	Vervaardigingskunde	3	x					x
wb6100	Materiaalkunde 1	3	x					
wb6200	Materiaalkunde 2	3	x					x
wi1313wb	Lineaire algebra 1	3				x		
wi1314wb	Lineaire algebra 2	3				x		
Total in EC			**40**	**13**	**28**	**32**	**16**	**41**

Other TU Delft BSc degree

The contents of the BSc degree and marks of each candidate will be evaluated by the intake coordinator of the board of examiners. The selection procedure can result in:

- Admission without additional requirements.
- Admission with additional requirements of less than 15 EC. In this case the total study programme will involve 120 EC.
- Admission with additional requirements between 15 and 45 EC. In this case 15 EC are part of the 120 EC of the regular MSc programme and at most an additional 30 ECs is required besides the regular MSc programme. The total study programme will involve 120 + max 30 = at most 150 EC.
- No admission. The candidate has to obtain the Marine Technology BSc degree first. Within the BSc programme exemption for some courses is possible, depending on earlier education.

With approval of the Board of Examiners the student can be conditionally admitted to the MSc programme, to take part in interim examinations of a few MSc courses. Requirements for conditional admission are: the student has passed the propaedeutic examination and has obtained at least 100 ECs of the second and third year, including the BSc thesis. Final admittance is granted after completion of the BSc programme.

1.4.2 BACHELOR'S DEGREE IN MARINE TECHNOLOGY OF DUTCH INSTITUTE OF PROFESSIONAL EDUCATION (HBO) OR THE 'HOGERE ZEEVAARTSCHOOL' (HZS)

A candidate can be admitted if he or she has completed the HBO or HZS Bachelor's programme within 4 years with good results. A number of additional courses from the second year of the Marine Technology BSc programme have to be taken. Candidates are admitted to the pre-Master's programme, which means that they can follow both the pre-Master's and MSc courses. Final admission to the MSc programme is given after completion of the pre-Master's programme.

- HBO and HZS students may attend courses and examinations of the chosen focus area while following the additional programme.

- HBO and HZS students have an exemption for the internship (15 EC) depending on their prior programme.
- HBO students are exempted from the 6 EC society-oriented courses.
- In consultation with the coordinator of the focus area, a number of courses will be included in the programme to comply with the BSc and MSc level of the focus area.
- The entire study programme for HBO student amounts to 34 + 120 - 15 = 139 EC.
- The entire study programme for HZS student amounts to 51 + 120 - 21 = 150 EC.

From September 2006 it is possible for Marine Engineering students of the Hogeschool Haarlem and the Hogeschool Rotterdam to follow a minor programme, which after completion of the BEng study gives unconditional admission to the Marine Engineering MSc programme. This minor involves a significant part of the pre-Master's programme (see table below), which can be followed during the third and fourth years of the HBO programme. To this end these students attend lectures, examinations and a project at Delft University two days a week. The missing part of the pre-Master's programme will be included in the MSc programme instead of the internship. The total study load of the MSc programme is the regular 120 EC in this case.

COURSE CODE	COURSE NAME	TH/HZS EC	TH-minor EC
Mathematics			
wi1152th	Analyse 1 th	3	3 (1e kw,jr3)
wi1153th	Analyse 2 th	3	-
wi1154th	Analyse 3 th	3	3 (3e kw,jr3)
wi2256th1	Lineaire Algebra th	3	3 (2e kw,jr3)
wi2256th2	Differentiaal Vergelijkingen th	3	3 (3e kw,jr3)
Mechanics			
Wb1217	Sterkteleer 2	3	3 (2e kw,jr3)
Wb1216	Dynamica 2	3	3 (4e kw,jr3)
Wb1218	Niet Lineaire Mechanica	2	-

Fundamental Wb/MT			
Wb1225	Stromingsleer	3	-
Wb2207	Regeltechniek	3	3 (1e kw,jr3)
Wb1224	Thermodynamica 2	3	-
Wb1321	Warmte en stofoverdracht	3	-
Extra in minor			
Wbtp211	Mechatronica project	-	10 (1e+2e kw,jr4)
Total pre-master's programme		35	
Total minor			31
Still to do in MSc programme			14

Additional courses HZS students

COURSE CODE	COURSE NAME	HZS EC
Wb1116	Dynamica	4
Wb2104	Inleiding modelvorming en regeltechniek	3

The TH/HZS admissions coordinator is ir. Jaap van der Zanden.
Secretary of the Board of Examiners is Ewoud van Luik.

1.4.3 BACHELOR'S DEGREE OF THE ROYAL NETHERLANDS NAVAL COLLEGE (RNNC)

RNNC 'KIM - Technische Dienst' graduates (5-year programme completed)

A selection of candidates will be made. Admission is possible if the candidate has completed the RNNC programme within 5 years, with good results. The intake coordinator of the board of examiners is responsible for this selection. Depending on earlier (RNNC) education, a study programme is drawn up. This programme has to be approved by the board of examiners. This programme should comply to the following requirements:

1. total minimal amount of 60 EC, including a compulsory specialisation part and MSc thesis
2. no internship
3. no society-oriented courses
4. MSc thesis worth at least 40 EC

Candidates who have completed the fourth RNNC year of study, including the practical operational introduction
After being selected by the intake coordinator, the candidate can be admitted. The programme consists of 100 EC, depending on the chosen focus area.

1.5 MSC PROGRAMME IN MECHANICAL ENGINEERING

Before entering the MSc programme, the student should compile a list of courses and submit it to the lecturer in the chosen focus area for approval. The relevant form is obtainable from the Faculty of 3mE Service Desk located behind the porter's lodge. The programme's general requirements are described in section 1.2.

Specialisations and focus areas in 2006-2007
There are six different specialisations in Mechanical Engineering, with a total of 18 focus areas.

1. Transportation Engineering (TE)
1.1 Transport Engineering and Logistics (TEL)
1.2 Production Engineering and Logistics (PEL)
1.3 Marine Engineering (ME)
1.4 Diesel Engines (DE)

2. Control Engineering (CE)

3. Sustainable Processes and Energy Technologies (SPET)
3.1 Energy Technology (ET)
3.2 Engineering Thermodynamics (ETh)
3.3 Process Equipment & Separation Technology (PS)
3.4 Fluid Dynamics (FD)
3.5 **Annotation** Sustainable Development (SD)

4. Production, Mechatronics and Microsystems (PMM)
4.1 Production Technology (PT)
4.2 Mechatronics (M)
4.3 Engineering Mechanics (EM)

5. Biomechanical Design (BMD)
5.1 Biorobotics (BR)
5.2 Biocompatible Design (BCD)
5.3 Intelligent Mechanical Systems (IMS)

6. Solid and Fluid Mechanics (SFM)
6.1 Fluid Mechanics (FM)
6.2 Engineering Dynamics (ED)
6.3 Mechanics of Materials (MM)
6.4 Structural Optimisation & Computational Mechanics (SO)

Students who have already started on one of the specialisations from the 2004-2005 academic year may complete that programme.

Annotations
There are also two annotations, which can be obtained as a supplement to the chosen specialisation and focus area.
a) Technical Marketing
b) Sustainable Development

1.5.1 TRANSPORTATION ENGINEERING SPECIALISATION (TE)

- Co-ordinator:
  Dr. Dingena L. Schott
  E-mail: d.l.schott@tudelft.nl
  Tel: +31 (0)15 27 83130 (82889 for appointments)

Free mobility and excellent transportation and handling systems for people and goods are cornerstones of the welfare accomplished in the industrialised world. Worldwide, ships transport more than 90 per cent of all goods – from raw materials to consumer products. For inland, hinterland and internal transport, reliable, cost-effective, efficient, fast and flexible transport systems are essential; these require integrated control of all processes in the chain.

Today, however, limits in transport capacity and the accessibility of cities, a perceived reduction of transport safety and reliability, increased environ-

mental pollution and the occupation of scarce areas and energy resources by marine and transport systems are placing ever-increasing pressure on society and industry. To ensure the future accessibility of cities, new transport systems such as underground networks have an important role to play. And new logistical concepts which influence the organisation of all the processes involved are required to safeguard the future profitability of industry.

To ease the scarcity of land and to reduce their environmental impact on society, large facilities such as airports may be moved offshore – either to large floating structures or to artificial islands. Marine and transport equipment is operated in a vulnerable environment and sometimes handles vulnerable objects. So safety, sustainability and reliability are key issues, a fact reinforced by increasing public awareness and decreasing acceptance of the consequences of major accidents at sea and on land.

Energy efficiency, air pollution and acoustic emissions are also major issues, given transport's large share of the world's energy consumption and environmental impact. Advanced, smart, fast, sustainable and safe marine and transport systems are therefore required to sustain welfare, to maintain an acceptable level of mobility and freedom of transportation and to strengthen the position of Dutch marine and transport companies in the world market.

The essence of Transportation Engineering is to develop, design, build and operate marine and transport systems and their equipment as an indivisible part of a supply chain. In recent decades, many new concepts and systems have been developed in this sector. Due to strong public pressure for more efficient and safer transport, and in order to improve the competitive position of the Dutch and European marine and transport sector, it can be expected that this trend will continue and accelerate.

New-generation transport, marine and industrial systems have to be based on new concepts, using distributed intelligence, combined with the application of smart components. This requires the further development of knowledge about the dynamics and the physical processes involved in these systems, about their logistics and about the interaction between equipment and control systems.

The Transportation Engineering specialisation has four focus areas.

- Transport Engineering & Logistics (TEL).
- Production Engineering & Logistics (PEL).
- Marine Engineering (ME).
- Diesel Engines (DE).

The Dredging Engineering focus area, formerly part of TE, has now been transferred to the MSc programme in Offshore Engineering.

The main topics of the Transport Engineering and Logistics (TEL) and Production Engineering and Logistics (PEL) focus areas are, respectively, the design, operation and control of transport and production systems and the design, operation and control of transport equipment and machinery.

The main topics of the Marine Engineering (ME) and Diesel Engines (DE) focus areas are the design and operation of propulsion systems.

A student of Transportation Engineering has to take 60 EC on courses during the first year of the programme. The final year of the programme consists of one or more projects, also worth a total of 60 EC.

Please contact the study co-ordinator for the focus area of your choice for more information or to discuss your individual study programme (ISP). Your ISP should be approved by the co-ordinator as early as possible, but certainly before the end of the first semester. For more information, see www.mtt.tudelft.nl under "Education".

1.5.1.1. TRANSPORT ENGINEERING & LOGISTICS FOCUS AREA (TEL)

- Prof. G. Lodewijks, tel. +31 (0)15 27 88793, e-mail G.Lodewijks@delft.nl
- Prof. J. C. Rijsenbrij, tel. +31 (0)15 27 86573, e-mail J.C.Rijsenbrij@tudelft.nl
- Co-ordinator: Dr Dingena L. Schott, tel. +31 (0)15 27 83130, e-mail D.L.Schott@tudelft.nl
- Secretary: Ms J. W. M. Spoek-Schouten, tel. +31 (0)15 27 82889, e-mail J.W.M.Spoek-Schouten@tudelft.nl

Transport and logistical systems are growing in terms of their size, capacity, complexity and environmental pollution. People, however, expect transport systems to be safe, flexible, efficient, reliable, and labour-extensive. To meet that public demand, future systems will have to be designed in a different way. The central problems are to determine (1) how to control and manage future transport systems, (2) how to power their components and (3) to what extend they should be automated.

The control systems used in transport today are centralised and mostly rigid. The applied intelligence is installed at the system level, not at the equipment or component level. It is therefore impossible to achieve the degree of safety, mobility, flexibility and increased capacity which are essential for tomorrow's systems. To do that, new tools for design, control, simulation and optimisation need to be developed, based on fundamental innovations and new insights into the physics of continuous transport phenomena, as well as the development of agile logistical control systems for discrete (event-driven) transport systems using distributed intelligence.

Most components of continuous transport systems are centrally driven. So their structures not only carry the weight and external loads, they also transfer the driving force. This results in heavy equipment and the continuous need for a large amount of power. Distributed drive systems which supply power exactly where it is required significantly reduce structural weight and power consumption. To enable the application and full utilisation of such drive systems, load-detection systems and intelligent drive-control systems need to be developed. Most components of discontinuous transport systems are locally driven. The flexibility and capacity of discontinuous long-distance transport systems can be significantly improved by the applying trains of – possibly hybrid – components. A proper assessment tool needs to be developed to determine the optimum drive configuration (centrally versus locally driven, electric motor versus combustion engine) and the corresponding intelligent control system.
The future automation of transport systems will be determined by costs, capacity, reliability and safety considerations, as well as by labour-extensity and information requirements. Central questions here are the extent to which systems need to be automated, the effect of that on the operator and the user, the kind of information required to control the system adequately and to provide users with the information they want, how that information is gathered and what sensors are required. The interaction between equipment on one hand and the operator and environment on the other hand is crucial for the safe and reliable operation of a transport system. The challenge is to optimise the operational performance of transport systems, taking into account for human limitations in knowledge of complex systems and their ability for deductive and inductive reasoning. It is also possible to use knowledge of the active status of components to automate maintenance procedures and to optimise the system's lifecycle and performance. Considering the complexity of transport systems, this is required to assist the operator to ensure safe and sound operation of a system and its equipment.

The table below shows the first-year compulsory and elective courses and the second-year assignment and project options in this focus area. Contact your study co-ordinator for more information and/or to discuss your individual study programme (ISP). This should be approved by the co-ordinator as early as possible, but certainly by the end of the first semester.

Compulsory courses

Course code	Course name	Contact hours	EC
wb3420-03	Introduction to Transport Engineering and Logistics	2/2/0/0	5
et3026wb 1)	Electrical Power Drives	0/3/0/0	31)
ae4-490	Maintenance Management		3
wb3410-03	Large-Scale Transport Systems	0/0/2/0	3
wb3417-04	Discrete Systems: Modelling, Prototyping, Simulation and Control	2/2/0/0	5
wb3419-03	Characterisation and Handling of Bulk Solid Materials	2/2/0/0	6
wb3421-04	Automation and Control of Transport and Production Systems	0/0/2/2	6
wb3422-03	Design of Transport Equipment	0/0/2/2	5
ct4330 2)	Harbours and Shipping Lanes	0/2/2/0	42)
ct4811 2)	Design and Control Public Transport Systems	0/4/0/0	42)
mt216	Introduction to Combustion Engines	0/2/0/0	3
Total: compulsory courses			**43**
Elective courses (the following two are recommended)			17
wm0605tu	Business Economics for Engineers		4
wb3423-04	Modelling of Industrial Systems	2/0/0/0	3
Assignments and MSc project			60
Total			**120**

1) Electrical Power Drives (et3026wb) has to be taken now if it was not part of a previous programme.

2) Choose between ct4330 and ct4811.

1.5.1.2. PRODUCTION ENGINEERING & LOGISTICS FOCUS AREA (PEL)

- Prof. G. Lodewijks, tel. +31 (0)15 27 88793, e-mail G.Lodewijks@tudelft.nl
- Dr H. P. M. Veeke, tel. +31 (0)15 27 82706, e-mail H.P.M.Veeke@tudelft.nl
- Secretary: Ms J. W. M. Spoek-Schouten, tel. +31 (0)15 27 82889, e-mail J.W.M.Spoek-Schouten@tudelft.nl

Production Engineering and Logistics aims to prepare future engineers to play an analytical, integrative and innovative role in new developments in the following areas.

- Production and logistical techniques; mastering and piloting new techniques, including automation.
- Existing systems; analysing production and logistical processes and control.
- The integration of processes, techniques and control, thereby perceiving the multidisciplinary character of these processes and becoming aware of the restrictions on the engineering discipline.
- New organisational structures for the integration of production and transportation.

The notion of the "specialist" has gradually been replaced by notions of process, integration and a systems-based view of supply chains. The use of these new ideas in industry and service has created the need for a course based on a methodology which offers a coherent and integrated approach to technology, organisation and information. An executive engineer has to master all the different aspects of productivity: knowledge of tools, machinery, equipment, information, operations and control systems, perception of human resources and the ability to contribute to and evaluate new industrial situations.

Production Engineering and Logistics prepares students for operations management line and staff positions in industry and engineering consultancy. Much emphasis is placed on modelling as an aid to analysing operational problems and to finding acceptable solutions. The final assignment addresses a real problem in a company or organisation.

Applied studies concern the automation and intelligent control of supply, production and distribution networks. Another rapidly developing area for projects and assignments is predictive modelling with simulation of industrial processes.

The complexity of production organisations has increased tremendously in recent decades due to changing customer demands, increased automation

possibilities, the real-time availability of information and rigid environmental conditions. The challenge for the engineer is to find solutions combining all these possibilities and restrictions. The design of a production organisation is considered to be a multidisciplinary project.

The combination of organisation and logistics offers a unique opportunity to study the complete value-adding chain in industry, composed of transformation and transportation processes. Students broaden their technological knowledge by always including organisational and informational aspects within the human business environment. They also learn the restrictions on their knowledge and recognise the need for economic, sociological and/or psychological contributions.

The programme uses a variety of teaching methods to achieve these objectives.

- Wide-ranging lectures on technology, approaches to industrial systems, information systems, operations research, simulation and business economics.
- A seminar to study, discuss and evaluate real-life cases with fellow students under the expert guidance of staff members.
- Laboratory work to gain experience with real-life systems and traineeships in industry.

Compulsory courses

Course code	Course name	Contact hours	EC
wb3420-03	Introduction to Transport Engineering and Logistics	2/2/0/0	5
et3026wb[1)]	Electrical Power Drives	0/3/0/0	3[1)]
ae4-490	Maintenance Management		3
wb3417-04	Discrete Systems: Modelling, Prototyping, Simulation and Control	2/2/0/0	5
wb3421-04	Automation and Control of Transport and Production Systems	0/0/2/2	6
wb3423-04	Modelling of Industrial Systems	2/0/0/0	3
wb3424-04	Production Organisation Principles	0/2/0/0	2
wb3425-04	Production Engineering Practical		5
in4050tu	Java and Object-Oriented Design	2/2/0/0	6
Total: compulsory courses			**38**
Elective courses (the following two are recommended)			22
in24102)	Introduction to Databases (PEL specialisation)		4[2)]
wm0605tu	Business Economics for Engineers		4
Assignments and MSc project			**60**
Total			**120**

[1)] Electrical Power Drives (et3026wb) has to be taken now if it was not part of a previous programme.
[2)] This course is usually worth 6 EC, but as a PEL student you take a shorter version worth 4 EC.

1.5.1.3. MARINE ENGINEERING FOCUS AREA (ME)

- Dr H. T. Grimmelius, tel. +31 (0)15 27 82746, e-mail H.T.Grimmelius@tudelft.nl
- Secretary: R. H. van Till, tel. +31 (0)15 27 86564, e-mail R.H.vanTill@tudelft.nl

Marine Engineering covers the design, installation and operational use of ship machinery and electrical plants. It covers a wide variety of systems, including ships' propulsion plants, electric power generation, refrigeration and climate control and auxiliary systems for cooling and lubrication, cargo handling, loading and unloading.
The discipline is also highly relevant to the design of land-based power plants and process systems.

The main issue in this discipline is "installation technology": the integration of different equipment to create well-functioning, efficient and cost-effective systems. This requires extensive knowledge of machinery and electrical equipment (operational principles as well as such characteristics as controllability and maintainability) as well as of fluid dynamics, mechanical vibrations and strength, thermodynamics, reliability and maintainability.
The design of the equipment to be installed is not a main topic of study.

Students specialising in Marine Engineering have a wide choice of elective courses. Several courses are mandatory under the specialisation rules, and students are also expected to take a number of focus area courses. About a third of the credit points during the first year of the programme can be earned from elective courses.

The Master's thesis is worth 60 EC and in many cases is prepared in co-operation with industry or an external research institute. The focus area has good contacts with universities abroad, which gives students the opportunity to take courses or write the thesis in another country.

The Master's thesis covers one of the research topics in which the section is active.

- Investigating the dynamic behaviour of machinery systems. To do this, much effort is devoted to developing simulation models of equipment and systems and to the dynamic simulation of complete systems.
- Maintenance engineering. The development of cost-effective and safe maintenance plans, as well as work on intelligent condition monitoring. Use is made of artificial intelligence and system simulations.
- Developing new design tools and innovative system designs.

The thesis may be either practical or more fundamentally theoretical in nature.

Examples of recent Master's thesis topics.

- Development of a simulation model of a dredging pump.
- Technical and economical investigation into an all-electric ship (AES) concept for a chemical tanker.
- Model development and simulation of the dynamic behaviour of a complete propulsion system (engine, propeller and ship) in a heavy seaway.
- Sensor monitoring with the help of neural networks.
- Development of an economical decision model for spare parts to be carried on board

Compulsory courses

Course code	Course name	Contact hours	EC
wb3420-03	Introduction to Transport Engineering and Logistics	2/2/0/0	5
et3026wb1)	Electrical Power Drives	0/3/0/0	3 [1)]
ae4-490	Maintenance Management		3
mt213	Marine Engineering C	0/2/0/0	2
mt216	Introduction to Combustion Engines	0/2/0/0	3
wb4408A	Diesel Engines A	0/0/4/0	4
wb4408B	Diesel Engines B	0/0/0/4	4
mt219	Marine Engineering A	0/0/0/6	4
mt527	Hydromechanics 3	0/4/0/0	2
Total: compulsory courses			**30**
Elective courses			30
Assignments and MSc project			60
Total			**120**

[1)] Electrical Power Drives (et3026wb) has to be taken now if it was not part of a previous programme.

1.5.1.4. MARINE DIESEL ENGINES FOCUS AREA (DE)

- Prof. D. Stapersma, tel. +31 (0)15 27 83051, e-mail D.Stapersma@tudelft.nl
- Secretary: R. H. van Till, tel. +31 (0)15 27 86564, e-mail R.H.vanTill@tudelft.nl

The Marine Diesel Engines, a focus area within Transportation Engineering focuses on the interaction between the components and subsystems which make up an engine (system approach). As well as a strong emphasis on the thermodynamic side, the marine applications of the diesel engine and user aspects (maintenance) are also considered.

The study of diesel engines at Master's degree level is wide-ranging, not just because such engines have so many applications but also because

all the basic aspects of mechanical engineering – construction and fluid mechanics, thermodynamics, materials, design and engineering, control theory and so on – must be considered in making the diesel engine an environmentally friendly, low-cost and low-maintenance element in mechanical installations.

Research is inspired by, but not limited to, marine applications and covers the following areas.

- Dynamic behaviour and control in relation to sea state and manoeuvring in ships.
- Sustainability in terms of low fuel consumption and emissions.
- Maintenance and reliability.
- Cost and economics.

Compulsory courses

Course code	Course name	Contact hours	EC
wb3420-03	Introduction to Transport Engineering and Logistics	2/2/0/0	5
et3026wb[1)]	Electrical Power Drives	0/3/0/0	3 [1)]
ae4-490	Maintenance Management		3
mt213	Marine Engineering C	0/2/0/0	2
mt216	Introduction to Combustion Engines	0/2/0/0	3
wb4408A	Diesel Engines A	0/0/4/0	4
wb4408B	Diesel Engines B	0/0/0/4	4
wb4429-03	Thermodynamics of Mixtures	0/4/0/0	3
wb4431-05	Evaluation of Processes and Energy Systems	0/0/4/0	4
wb4302	Thermodynamics of Energy Conversion	4/0/0/0	4
Total: compulsory courses			35
Elective courses			25
Assignments and MSc project			60
Total			120

[1)] Electrical Power Drives (et3026wb) has to be taken now if it was not part of a previous programme.

Dredging Engineering focus area (MSc Offshore Engineering)

From the 2005-2006 academic year, Dredging Engineering is being offered as a focus area of the Master's programme in Offshore Engineering. This means that interested in this focus area now have to enrol for MSc Offshore Engineering.

For more information please contact:

- Dr S. A. Miedema, tel. +31 (0)15 27 88359, e-mail S.A.Miedema@tudelft.nl
- Secretary: Ms P. Bokop-van der Stap, tel. +31 (0)15 27 86529, e-mail P.Bokop-vanderStap@tudelft.nl

1.5.2. CONTROL ENGINEERING SPECIALISATION (CE)

- MSc specialisation co-ordinator: Dr Sjoerd Dijkstra, tel. + 31 (0)15 27 85606, e-mail s.dijkstra@dcsc.tudelft.nl

Control Engineering is about the analysis and design of reliable high-performance measurement and control strategies for a wide variety of dynamic technological processes. It focuses on the fundamental aspects of modelling dynamic systems and on developing algorithms for controller design. This variant places particular emphasis on two fields of industrial application: advanced process control and motion control for electromechanical and servohydraulic systems.

The curriculum embraces fundamental techniques for the physical and experimental modelling of dynamic systems as well as modern approaches to optimisation-based controller synthesis for multivariable systems. This is supplemented by courses on the hardware and software aspects of the technical implementation of control systems, including plenty of practical training in laboratory-based experimental projects. Students can choose between two focal areas: Mechanical Systems and Processes. These interdisciplinary courses cover advanced control techniques for high-performance mechatronic or hydraulic systems (such as a wafer stage or a flight simulator), as well as complex chemical or industrial processes (such as crystallisers or transportation systems).

In consultation with the MSc supervisor, the student chooses a graduation project related either to fundamental aspects of systems and control or to one of the areas of application in mechanical systems (mechatronics, microsystems, MEMS, robotics) or process control (biotechnological, chemical, petrochemical and production processes). Most MSc theses fall within the scope of an ongoing research project at the Delft Centre for Systems and Control (DCSC) and are supervised by a member of its academic staff under the auspices of a DCSC professor. Alternatively, theses can be prepared in collaboration with the Advanced Mechatronics group, with Professor J. van Eijk acting as supervisor.

Course code	Course name	Contact hours	EC
MSc FIRST YEAR			
Compulsory			
sc4020	Control Theory	4/0/0/0	6
sc4031	Modelling and System Analysis	0/4/0/0	4
sc4050	Integration Project SC	None	5
sc4110	System Identification	0/0/4/4	5
wb2305	Digital Control	0/4/0/0	3
wb2421	Multivariable Control	0/4/0/0	6
wb2423	Introductory Project	None	3
Compulsory courses: subtotal			**32**
10 EC selected from the following MECHANICAL SYSTEMS or PROCESSES courses			
Elective courses: Mechanical Systems			
wb1406-05	Experimental Dynamics	0/0/2/2	4
wb1413-04	Multibody Dynamics	0/0/2/2	4
wb1418	Engineering Dynamics	2/2/0/0	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1442	Introduction to Microsystems	2/2/0/0	3
wb2303	Measurement Theory and Practice	0/0/2/2	3
wb4432-05	Process Dynamics and Control	0/0/0/4	3
wb2414	Mechatronics	2/2/0/0	3
wb2426	Chemistry and Chemical Plant	0/0/2/2	3
wb2428-03	Mechanical Construction Principles	2/2/2/0	5
wb3404A	Vehicle Dynamics A	0/0/2/2	3
wb5420-03	Design of Production Systems	4/0/0/0	3
wb5421-03	Modelling of Production Machinery	0/0/0/2	3
wb5422-03	Industrial Assembling	0/0/4/0	3
Elective courses: Processes			
st2442	Process Systems Analysis		4
st7011	Elements of Chemical Process		2
wb3421-04	Automatic Transport Systems	0/0/2/2	6
wb4432-05	Process Dynamics and Control	0/0/0/4	3
wb2426	Chemistry and Chemical Plant	0/0/2/2	3
wb4417	Design of Process Equipment	0/2/0/0	3

Elective courses: Fundamentals (10 EC to be selected)			
sc4060	Model Predictive Control	0/0/3/0	4
sc4090	Optimisation in Systems and Control	4/0/0/0	3
sc4130	Modern Robotics	0/0/4/0	3
sc4150	Fuzzy Logic & Engineering Applications	3/0/0/0	3
sc4160	Modelling and Control of Hybrid Systems	0/0/4/0	3
wb2415	Robust Control	0/0/4/0	6
wb2416	Linear Matrix Inequality in Control	0/0/0/4	6

Summary

MSc FIRST YEAR	
Compulsory Courses	32
9 EC Mechanical Systems or 9 EC Processes	10
Fundamentals	10
Free elective courses	8
Subtotal	60

MSc SECONDYEAR	
Industrial traineeship	(10)
Literature study	15
MSc thesis	(45)
Subtotal	**60**
Total	**120**

MSc Systems and Control versus MSc Mechanical Engineering, Control Engineering specialisation

A student's perspective.

If you have a BSc in Mechanical Engineering and wish to pursue a Master's study in field of systems and control engineering, there are two options you choose from.

1. MSc Systems and Control
2. MSc Mechanical Engineering, selecting the Control Engineering specialisation

Below we explain the main differences between these two options, with the arguments for choosing one or other of them.

First the main differences.

- MSc Systems and Control takes the technological aspects of systems and control engineering as its starting point. The subject is approached from its generic themes (system theory, control theory, signal analysis), with its highly multidisciplinary nature revealed through different fields |of application in which systems and control engineering plays its part: high-precision motion control systems (mechatronics, robotics, microsystems), industrial process systems, traffic and transportation systems and physical imaging systems. Students take a limited number of compulsory courses (24 EC) directed towards the generic components of the field: modelling, control theory, signal analysis and laboratory projects. They complete their programme with elective courses chosen from an extensive list. The MSc project is prepared under the supervision of a professor from the DCSC or one of the affiliated groups: Advanced Mechatronics, Man-Machine Systems, Process Systems Engineering (Faculty of Applied Sciences), Control and Simulation (Faculty of Aerospace Engineering), Mathematical System Theory (Faculty of Electrical Engineering, Mathematics and Computer Science), Bioprocess Technology (Faculty of Applied Sciences) or Dynamic Traffic Management (Faculty of Civil Engineering and Geosciences). Upon successful completion of the programme, students are the awarded the degree MSc Systems and Control.

- The Control Engineering specialisation of MSc Mechanical Engineering takes mechanical engineering as its starting point. It studies the development and application of system and control engineering concepts in the context of mechanical engineering problems, such as high-precision motion control systems (mechatronics, robotics, microsystems) and industrial process systems. Students take more compulsory courses, with an emphasis on mechanical engineering subjects, as well as systems and control courses which partly overlap with those in the dedicated MSc programme. The MSc project is prepared under the supervision of a professor from the DCSC or the Advanced Mechatronics group. Upon successful completion of the programme, students are awarded the degree MSc Mechanical Engineering, with a mention that the addition Control Engineering specialisation was taken.

Both options open up excellent career prospects after graduation. When choosing between them, it is advisable to consider how you eventually wish to profile yourself professionally.

To be recognised as a dedicated systems and control engineer, the BSc Mechanical Engineering followed by MSc Systems and Control is the best choice for you. The combination of these two degrees indicates that you have a solid mechanical engineering background but that you have transcended the traditional boundaries of that discipline at MSc level to master the more abstract field of systems and control engineering, thus bringing a strong multidisciplinary component to your university education.

If you feel strongly committed to mechanical engineering and wish to be recognised professionally as a mechanical engineer, then the best option for you is BSc Mechanical Engineering followed by MSc Mechanical Engineering.

1.5.3. SUSTAINABLE PROCESSES & ENERGY TECHNOLOGIES SPECIALISATION (SPET)

- Co-ordinator: Dr. C. A. Infante Ferreira, tel. +31 (0)15 27 84894, e-mail c.a.infanteferreira@tudelft.nl

There is widespread agreement that human activities, and specifically industrial processes, are sustainable if they promote development which "meets the needs of the present without compromising the ability of future generations to meet their own demands". That, of course, poses formidable and urgent technical challenges. This Master's programme offers the motivated student the chance to play a fundamental role in this primal human enterprise. The knowledge acquired by specialising in SPET gives students the technological understanding and skills (theoretical, numerical and experimental) they need to help develop the energy and process technologies of the next generation. Moreover, they become aware of the importance of sustainable development to our society and acquire the tools necessary to promote it.

This specialisation opens up opportunities to pursue a career either in industry, where design and development play a major role, or in academia, where science dominates. Most SPET graduates find process and energy-related jobs.

The MSc programme is divided in parts, which are summarised in the "Curriculum" table.

An initial series of compulsory courses (42 EC) trains the student in key basic disciplines: thermodynamics, fluid dynamics, process modelling and simulation, process equipment design and so on. They guarantee a sound theoretical basis in both process and energy engineering. All these courses consider sustainability, and they are complemented by two specific courses providing the skills and imbuing the attitude needed to contribute to more sustainable process and energy solutions.
The compulsory component of the programme includes a process modelling and simulation project (9 EC), which is scheduled for the second year. Since software skills are very important for a new engineer embarking on his or her the beginning of his career, this project includes training in the use of process and energy-related computer programs. Students work on this project in teams.

Another set of courses (24 EC) is elective and allows the student to choose one of the four SPET focus areas.

- Energy Technology (ET)
- Engineering Thermodynamics (Eth)
- Process Equipment & Separation Technology (PS)
- Fluid Dynamics (FD)

Courses are selected from the list in the "Elective courses" after consultation with the co-ordinator of the chosen focus area.

The individual course components include a traineeship with a company (15 EC) and the final project (30 EC). The former helps the student understand the kind of expertise demanded by the market. The latter is linked to one of the research programmes run by the Department of Process and Energy, is tailored to industry demands and includes a mix of fundamental and applied research.

SPET students are encouraged to obtain the additional Technology in Sustainable Development Certificate. In order to do that, they must participate in a colloquium (4 EC) and obtain at least 5 EC in courses related to sustainable development. Moreover, their final project must include an evaluation of the contribution to sustainable development provided by their research topic. More details of this additional qualification can be found below.

CURRICULUM

COMPULSORY COURSES

Course code	Course name	Contact hours	EC
FUNDAMENTAL COURSES			
wb1427-03	Advanced Fluid Dynamics	2/2/0/0	5
wb4302	Thermodynamic Evaluation of Processes and Systems	4/0/0/0	4
wb4429-03	Thermodynamics of Mixtures	0/4/0/0	3
MODELLING, ANALYSIS AND SYNTHESIS			
wb4431-05	Modelling of Processes and Energy Systems	0/0/4/0	4
wb1428	Computational Fluid Dynamics	0/0/2/2	3
wb4433-05	Conceptual Process Design and Optimisation	0/0/0/4	4
wb4432-05	Process Dynamics and Control	0/0/0/4	3
SUSTAINABLE PROCESSES AND ENERGY TECHNOLOGIES			
wb4435-05	Equipment for Heat Transfer	4/0/0/0	3
wb4436-05	Equipment for Mass Transfer	2/2/0/0	3
wb4300b	Fundamentals of Fluid Machinery	0/0/0/2	2
wb4400-03	Introduction to Sustainable Processes and Energy Technologies	0/0/0/0	1
SUSTAINABILTY COURSES			
IExxxx	Advanced Course on LCA	Int. course 2nd period	4
wb4438-05	Energy, Society and Sustainability	0/0/4/0	3
	Compulsory courses		42
	Elective courses		24
me03spt01	Process Modelling and Simulation Project		9
me03spt02	Traineeship		15
me03spt03	Final project		30
	Total		120

ELECTIVE COURSES

Course code	Course name	Contact hours	EC	ET	PS	Eth	FD
FUNDAMENTAL COURSES							
ap3151D	Advanced Thermodynamics	0/0/2/2	3	r			r
ap3171D	Advanced Physical Transport Phenomena	0/0/0/4	6		r	r	r
ap3181D	Applied Multiphase Flows	0/0/2/2	6	r	r	r	s
wb1424Atu	Turbulence A	0/0/2/2	6		r	r	s
wb1424B	Advanced Turbulence		3				r
wi4019	Non-Linear Differential Equations		6		r		r
TECHNOLOGY-ORIENTED COURSES							
ae4-140	Gas Dynamics I		3	r			r
ap3571R	Radiative Heat Transfer	2/2/0/0	6				r
ch3491	Stability, Efficiency & Controllability of Dynamic Systems	Int. course 4th period	3	r	r	r	
ch3621	Process Intensification	Int. course 2nd period	6	r	r	r	
wb1408A	Shell Structures – Introductory	0/0/4/0	3		r		
wb1408B	Shell Structures – Advanced	0/4/2/0	5		r		
wb1429-03	Microfluidics	0/0/2/2	3				r
wb4402	Project Engineering	0/0/2/2	6	r	r	r	
wb4403	Separation Processes	0/0/4/0	4		s	r	r
wb4405	Fuel Conversion	4/0/0/0	3	r		r	
wb4410A	Refrigeration Fundamentals	4/0/0/0	3	r		s	
wb4416	Nuclear Engineering	0/0/4/0	3	r		r	
wb4417	Mechanical & Hydraulic Design of Process Equipment	-	3		s		

wb4418	Offshore Gas and Oil Processing	0/0/4/0	4		r	r	r
wb4420	Gas Turbines	2/2/0/0	3	r	r	r	
wb4421	Gas Turbines: Application and Simulation	0/0/2/2	3	r		r	
wb4422	Thermal Power Plants	0/0/4/0	4	s		r	
wb4425	Fuel Cell Systems	None	2	r		r	
wb4426	Indoor Climate-Control Fundamentals	4/0/0/0	3	r		r	
wb4427	Refrigeration Design & Applications	0/0/2/2	4	r		r	
ECONOMICS AND MANAGEMENT COURSES							
wm0605tu	Business Economics for Engineers		4				
wm0621tu	Innovation Management		3				

TECHNOLOGY IN SUSTAINABLE DEVELOPMENT CERTIFICATE

Course code	Course name	Contact hours	EC	ET	PS	ETh	FD
wm0922tu	Colloquium in Technology in Sustainable Development		4	r	r	r	r
CLUSTER A: DESIGN, ANALYSIS AND TOOLS							
ae3-w01	Introduction to Wind Energy		3				
ap3141_D	Environmental Physics		6				
et4149	Solar Cells		3				
id4125	Lifecycle Engineering and Design		6				
ie3301	Sustainable Processes & Products		3				
ie3320	Introduction to Renewable Energy Systems		3				

CLUSTER B: MANAGEMENT, POLICY AND SOCIETY							
id5351	Applied Environmental Design		3				
wm0321TU	Milieufilosofie		3				
wm0615TU	Environmental Economics		4				
wm0801TU	Introduction to Safety Science		3				
wm0903TU	Technologie en mondiale ontwikkeling		4				

r = recommended course.
s = strongly recommended course.

1.5.3.1. ENERGY TECHNOLOGY FOCUS AREA (ET)

- Vacancy (acting co-ordinator: Dr P. Colonna, Associate Professor, tel.+31 (0)15 27 82172, e-mail P.Colonna@TUDelft.nl)
- Secretary: +31 (0)15 27 86734, e-mail secr.et-3mE@TUDelft.nl

Energy is the vital force powering business, manufacturing and the transportation of goods and services to serve the world economies. And demand for energy is growing at an impressive rate: the US Energy Information Administration forecasts an increase of 54 per cent in the next two decades. Meanwhile, the related environmental impact of pollutants involved in energy conversion processes is one of the major problems facing humanity. The so-called greenhouse effect is possibly the worst environmental menace related to anthropogenic energy conversion. Moreover, energy supply and demand are playing an increasingly important role in the national security of developed and developing countries – the Netherlands included. One of the fundamental challenges for the future is the sustainable production of energy, with gradual emancipation from fossil fuels essential because of their increasing scarcity and the associated political danger. This can only be achieved by technological improvement and innovation.

The objective of the Energy Technologies focus area is to develop a thorough understanding of energy conversion and utilisation technologies. Students learn about state-of-the-art analysis tools and apply them to study highly efficient, environmentally friendly and integrated processes

for the production and utilisation of heat, power and secondary fuels like hydrogen. Recommended courses cover such relevant topics as advanced power generation, combined cycles, decentralised heat and power production (including fuel cells), heat pumps and energy utilisation in buildings. Other topics in specialised courses include fuel conversion, gas turbines and nuclear power engineering.
The section's research activities focus on both systems and components. The system-related studies aim to improve the complete chain of energy production and utilisation, the thermodynamic design of processes and their integration into larger systems and online optimisation using modern diagnostic tools. Examples include advanced biomass utilisation concepts such as gasification in combination with fuel cells, gas or ORC turbines and hydrogen production. Component-level research is related to combustion, co-combustion and gasification in fluidised bed and/or pulverised fuel systems and the combustion of LCV gases in gas turbines.

1.5.3.2. ENGINEERING THERMODYNAMICS FOCUS AREA (ETH)

- Vacancy (acting co-ordinator: Dr. C. A. Infante Ferreira, tel. +31 (0)15 27 84894, e-mail c.a.infanteferreira@tudelft.nl)
- Secretary: +31 (0)15 27 86734, e-mail secr.et-3mE@TUDelft.nl

Thermodynamics is the science of converting both matter (Gibbs) and energy (Carnot). Since the synergy between the process and energy domains is largely the result of common thermodynamic fundamentals, research in Engineering Thermodynamics is interdisciplinary and covers both.

Sustainability is related to the reversibility of processes. Quantifying and understanding irreversibilities in processes allows for the design of more sustainable ones. Here, non-reversible thermodynamics provides students with the tools they need to devise more sustainable design solutions.

Transport phenomena, in terms of momentum, energy, mass and charge, play a major role in process and energy conversion processes. So part of the research effort is directed towards the understanding and quantification of the interaction between these phenomena in process and energy equipment.

Current research activities include investigations into refrigeration and heat-pump technology topics. These thermodynamic cycles allow for an upgrading of energy and so can significantly improve the sustainability of processes. The research is focusing on the development of challenging concepts based on advanced sorption processes in combination with energy storage with phase-change materials. Most final degree projects are developed in co-operation with public agencies and private organisations.

1.5.3.3. PROCESS EQUIPMENT & SEPARATION TECHNOLOGY FOCUS AREA (PS)

- Process Equipment: Prof. G. J. Witkamp
- Separation Technology: Prof. P. J. Jansens
- Secretary: Ms H. Duijndam, tel. +31 (0)15 27 86678, e-mail W.L.E.Duijndam@TUDelft.nl

Both economically and technologically, separation processes are key to the success of most oil and gas, chemical, waste water, pharmaceutical and food plants. The Process Equipment and Separation Technology section (PE/ST) is positioned between science and industry: its research activities aim to develop innovative separation technologies and to optimise existing separation processes.

Most streams in an industrial plant combine several components. One of the major tasks of PE/ST is to develop technologies for the separation of components out of such a mixture. The section is recognised internationally for its design and operation of novel equipment and for the development of innovative separation processes on industrial scale.

The role played by separation technology and process equipment can be appreciated upon looking at the current energy consumption of the Dutch chemical and petrochemical industries: in 2000, of the country's total annual consumption of primary energy, 2500PJ, some 352PJ was used in separation processes. This huge figure is matched by the amount spent on separation equipment, which on average consumes well over 50 per cent of all investments in the industries mentioned. The development of

efficient separation processes is therefore of the outmost relevance, both as regards the SPET curriculum and in the research efforts by the PE/ST section.

Both by teaching the engineers of the future and by conducting its own research, PE/ST can contribute successfully to more efficient and environmentally benign technologies if the fundamentals of heat and mass transfer and of thermodynamics are correctly applied. The chair of the section considers it vital that an integrated view be adopted and that close ties be maintained with related disciplines – specifically ET, ETh and FD. Typical research projects are looking at the use of non-toxic or non-volatile ("green") solvents rather than more harmful fluids and at two highly selective separation technologies which are capable of reducing the energy consumption involved, namely industrial crystallisation and membrane separation processes.

Students specialising in Process Equipment and Separation Technology receive the knowledge and skills they need to systematically define, design and optimise a variety of processes and the appropriate equipment.

1.5.3.4. FLUID DYNAMICS FOCUS AREA (FD)

- Prof. J. Westerweel, tel. +31 (0)15 27 86887, e-mail j.westerweel@tudelft.nl
- Secretary: Ms R. van der Brugge, tel. +31 (0)15 27 82904, e-mail R.vanderBrugge@TUDelft.nl

Almost all equipment and systems in process engineering and energy technology – turbines, mixing reactors, piping systems, heat exchangers and so on – involve flowing liquids and gases. These flows are generally very complex and non-ideal (ie. turbulent) and they often consist of different phases (eg. liquid/gas, liquid/solid, gas/solid or liquid/liquid, where the gas, liquid or solid occurs in the form of small bubbles, particles or droplets). A thorough understanding of the transport processes for heat and mass in various systems requires detailed knowledge of turbulent flows and of how they relate to other processes, such as turbulent mixing and chemical reactions, turbulent multiphase flows and turbulence in relation to sound production.

The Fluid Dynamics focus area trains students in the fundamental aspects and applications of incompressible fluid flow. Particular attention is paid to turbulence and multiphase flow, which are the flow types that occur in the process and energy industry. With a view to modern technology, much emphasis is placed on numerical fluid dynamics (NFD) and its use in solving various practical problems. There is also much consideration for experiments in fluid mechanics, usually in combination with the numerical solution of flow problems – either for validation purposes or to solve those problems which cannot be investigated experimentally.

By the end of this focus area, the student has been trained in all aspects of modern fluid mechanics, both in the classroom and through specialist research work. Current research activities include investigations of dispersed multiphase flows (turbulent flows containing small particles), of turbulence in relation to mixing, of chemical reactions and combustion, of transition to turbulence and turbulence control in pipe flow, of multiphase flow (liquid/liquid mixtures and gas/liquid/solid mixtures), of turbulence and sound production and of microfluidic flows.

1.5.3.5 TECHNOLOGY IN SUSTAINABLE DEVELOPMENT ANNOTATION (SD)

- SD co-ordinator: Prof. A. H. M. Verkooijen, tel. +31 (0)15 27 86687, e-mail a.h.m.verkooijen@tudelft.nl
- Secretary: tel. +31 (0)15 27 86734, e-mail secr.et-3mE@TUDelft.nl

This certificate is obtainable as an optional addition to the SPET focus area. To qualify, a student must complete three programme components.

1. **Colloquium** A two-week seminar (4 EC) on during which students work on topical sustainability issues and approaches in interdisciplinary groups. At the heart of this course are sociotechnological scenarios and current developments related to society and the role of technology. The colloquium is held twice a year, in April and October. It is limited to a maximum of 20 students, so prompt registration is essential. To register, contact the Sustainable Development Education Secretariat (ODO)

on +31 (0)15 27 83791 or e-mail A.T.M.Dokkuma-tenDam@TUDelft.nl or K.H.J.vanDuyn-Derwort@TUDelft.nl

2. **Elective courses package** SPET students must choose a balanced programme of at least two courses (5 EC in total) related to sustainable development drawn from two clusters (at least 2 EC per cluster). These clusters are (A) Design, Analysis and Tools and (B) Management, Policy and Society. The SD co-ordinator can advise students on their selection (see the "Elective courses" table).

3. **Final project addressing sustainability issues** Students must incorporate coverage of sustainability issues specific to their discipline in their graduation project. The SD co-ordinator evaluates this aspect of the project, both prior to commencement and upon completion, looking at how SD has been considered in defining the problem, in the actual development of the project and in the conclusion reached. The SD co-ordinator then advises the Board of Examiners regarding award of the Sustainable Development annotation. The supervising professor retains responsible for evaluating project as a whole.

The table below summarises the requirements for SD annotation (Forms for the additional certificate).

Colloquium	4 EC
Compulsory sustainability courses	7 EC
Elective courses	4 EC
Final project	30 EC
Total	45 EC

1.5.4 PRODUCTION, MECHATRONICS AND MICROSYSTEMS SPECIALISATION (PMM)

- Coordinator: J. J. L. Neve, tel. +31 (0)15 27 86581, e-mail j.j.l.neve@tudelft.nl

The Production, Mechatronics and Microsystems (PMM) specialisation offers a strong and unique combination of disciplines, allowing MSc Mechanical Engineering students to specialise in a range of advanced but closely related technical fields. The scope of the variant is defined by a number of basic areas of knowledge which are applied to a variety of applications (see diagram). These domains encompass technical challenges at all levels – from precision machines (eg. wafer steppers, manufacturing machinery) and to subsystems (eg. smart suspension systems for cars) to highly miniaturised systems and microsystems (eg. micro-electromechanical systems used for micropositioning purposes).

The PMM specialisation is supported by the groups which make up the department of Precision and Microsystems Engineering (PME), a domain which encompasses some of the major technical challenges facing modern industry. For example, precision machinery such as wafer steppers and wafer scanners which have to operate with nanometric positioning accuracy. Or the ultra-precise production of workpieces for, say, the automotive industry. Microsystems, often referred to as MEMS (micro-electromechanical systems), are based on tiny components with dimensions in the sub-mm range and feature subdimensions in the micrometre range.

The scope of this specialisation includes such fields as automotive parts, sports equipment, aerospace and biomechanics, where advanced simulation, mechatronics, smart microsystems and production techniques are essential innovation factors.

Specialisations

The PMM specialisation is divided into three focus areas.

- **Production Technology (PT**)
  - Precision Manufacturing and Assembly (PMA): vacancy (acting chair: Dr M. Tichem).
- **Mechatronics (M)**
  - Mechatronics Design (MD): vacancy.
  - Advanced Mechatronics (AM): Prof. J. van Eijk. This focus area also covers Vehicle Mechatronics (Dr E. J. de Vries) and Tribology (Dr A. van Beek).
- **Engineering Mechanics (EM)**
  - Structural Optimisation and Computational Mechanics (SOCM): Prof. A. van Keulen.
  - Engineering Dynamics (ED): Prof. D. J. Rixen.
  - Mechanics of Materials (MM): Prof. L. J. Ernst.
  - Microsystems Reliability: Prof. K. Zhang.

The curriculum has been designed to offer the student maximum flexibility and added value.

- The common compulsory course for all three focus areas introduce the working areas of the PMM engineer. They include mechatronic design, production principles, problem solving and design using computational modelling, control and basic laboratory skills.
- All of the focus areas require – although in different ways – that at least one of the individual assignments be carried out in industry (training period).
- Although students have to choose a particular focus area, individual assignments may encompass more than one of them. For instance, a student who designs a mechatronic system may wish to delve deeper into its mechanics – and so that assignment may be supervised jointly or solely by the professor who is expert in that field. Or a Production Engineering student may discover that optimising a production process requires the development of an advanced production system including sensor and control systems. This may lead to co-operation with the Mechatronics group.

A detailed overview of the curriculum is provided below.

As well as the common component for all the focus areas, each has own first-year curriculum of compulsory elements and elective courses. The second year is devoted to applying and integrating of knowledge and skills through individual assignments. The final assignment is a thesis on one or more of the PME research themes. This may be prepared in an industry setting or in the research environment of the Department of PME. All students of PME are expected to give oral presentations about their literature or research assignment and about the results of their final assignment. An industrial traineeship in the Netherlands or abroad is a mandatory component of the curriculum.

The complete MSc programme consists of courses worth 60 EC plus individual assignments and projects worth another 60 EC.

Curriculum summary by focus area (EC)	PT	M	EM
Compulsory core courses	23	23	23
Compulsory focus area courses	20	22	14
Elective courses	17	15	23
Small-scale design, research and/or literature assignment	10	10	10
Industrial traineeship	15	15	15
Master's thesis	35	35	35
Total EC	120	120	120

Entrants from Dutch higher technical college ("TH-ingenieur") programmes

Candidates who hold a relevant Dutch vocational Bachelor's degree (HBO) or nautical college qualification may be admitted to this specialisation by ballot. See the general information on admission to MSc programmes.
A total of 140 EC must have been awarded. Students who have taken an "HBO minor" follow a slightly different program; again, see the general information.

Curriculum summary by focus area (EC) for HBO entrants	PT	M	EM
Mechanical Engineering Pre-Master's programme	35	35	35
Compulsory core courses	23	23	23
Compulsory focus area courses	20	22	14
Elective courses	17	15	23
Small-scale design, research and/or literature assignment	10	10	10
Master's thesis	35	35	35
Total EC	140	140	140

1.5.4.1 PRODUCTION TECHNOLOGY FOCUS AREA (PT)

- Acting Chair: M. Tichem, tel. +31 (0)15 27 81603, e-mail m.tichem@tudelft.nl
- Information and enrolment: J.J.L. Neve, tel. +31 (0)15 27 86581, e-mail j.j.l.neve@tudelft.nl
- Secretary Ms M.E.M. Guffens, tel +31 (0)15 27 86578, e-mail m.e.m.guffens@tudelft.nl

Production Technology focuses on technical knowledge about and the organisation of the entire production chain, including processes, machines and tools. The student acquires the knowledge and skills needed to develop the most suitable production and assembly processes for advanced discrete products. These are gained in the context of the challenges thrown up by the PMA group's own research, as well as those originating with the national and international network of companies with which it maintains close contacts. The focus of the group's research is the development of technology for the production of precise and small products.

This focus area aims to prepare engineers for a career in companies which develop and manufacture advanced products. Knowledge of advanced production technologies is essential to their competitive position. After graduation, these engineers typically become project leaders in production companies, playing an important role in developing the innovative production engineering knowledge they need. Introducing new technological developments, for example, or optimising the performance of a production process, supporting the industrialisation of prototype products and production processes or leading projects to optimise and rationalise entire production systems.

The PT curriculum teaches students the knowledge essential to a career as a production engineer. This profession demands know-how in a broad set of domains, including manufacturing and assembly processes, machines and tooling, production automation and production organisation. The individual assignments are conducted within the context of PMA's research or in co-operation with our industrial partners, offering a wide variety of opportunities to gain a broad spectrum of skills in such areas as the design and construction of mechatronic tooling for micro-assembly, the modelling of manufacturing processes, experimental research on processes using our laboratory infrastructure and the optimisation of production systems.

Recent assignments include…

- The design, optimisation and experimental evaluation of a gripper for handling micro-parts which works by freezing and melting a small amount of intermediate liquid between the gripping head and the part to be gripped (MSc assignment).
- Force measurement in high-pressure waterjet machining (experimental small-scale research assignment).
- Optimisation of laser machining for the manufacture of small, ultra-precise moulds (MSc assignment, in co-operation with a Dutch company).
- The development of a self-adjusting mechanism for the alignment of optical fibres (MSc assignment in co-operation with the Delft Institute for Microelectronics and Submicron Technology).
- Development of a new concept for assembly systems which can deal with variation in production volumes asked for over time (MSc assignment, in co-operation with a Dutch company).
- Research on a concept for the feeding of small parts in the context of micro-assembly (MSc assignment in co-operation with the EPFL, Lausanne, Switzerland)
- Research into the optimum production of sheet-metal blanks at Fokker Papendrecht.

- Modal analysis and proposals for design improvement to a vertical milling machine at Unisign, the Netherlands.

The obligatory industrial traineeship, which is an important step in professionalising the engineer-to-be, has taken our students all over the world: China, the UK, Australia, South Africa, Brazil, Germany, Dubai, Japan, the USA, Taiwan, Spain…

Research in Production Technology covers two main fields: precision parts manufacturing and micro-assembly. New techniques are being developed, or current ones combined, to improve the machining of advanced engineering materials. Processes intended to generate high degree of accuracy in parts and part features are being investigated, with a focus on the processing of advanced engineering materials and the realisation of complex functional part properties. Other research projects concern loose and bonded abrasive processes, high-speed machining and combined processes. State-of-the-art CNC machine tools are available at the PMA laboratory. As well as actual process development, research activities also include improvement of the necessary machine and other tools. The experimental work is supported by simulations to predict process and system behaviour.

Micro-assembly is characterised by part sizes down to the sub-millimetre range and by a high degree of accuracy in joining parts of between 0.1 and 10.0µm. The parts concerned are drawn from different technological fields: the semiconductors domain with components processed using silicon wafer-oriented techniques and the precision/micromechanical engineering domain with a wide range of parts (mechanical, optical, etc.) The current focus is on micro-part feeding, micro-part gripping, self-adjustment of optical interconnects (alignment of optical fibres to diodes, for example) and massive wafer-level assembly of small components.

First-year courses: MSc Mechanical Engineering, PPM variant, PT focus area			
Course code	Course name	Contact hours	EC
Compulsory courses (PPM specialisation)			
sc4021	Control Theory for PMM	4/0/0/0	4
wb1442	Introduction to Microsystems	2/2/0/0	3
wb1450-05	Mechanical Analysis for Engineering	3/2/0/0	4
wb2414	Mechatronics (design)	2/2/0/0	3
wb5434-05	Micro-assembly, Packaging and Testing	0/0/4/0	3
wb5450-05	Selected Topics in PME	0/0/0/2	1
wb5451-05	Attending student colloquia	1/1/1/1	1
wb5452-05	Introduction to PMM Laboratory	2/2/2/2	4
Total EC: compulsory courses (PPM specialisation)			23

Compulsory courses: Production Technology focus area (PT)			
wb2303	Measurement Theory and Practice	0/0/2/2	3
wb2427	Predictive Modelling	0/0/4/0	3
wb3424-04	Production Organisation Principles	0/2/0/0	2
wb5414-03	Design of Machines and Mechanisms	2/2/0/0	3
wb5420-03	Production systems and their Design	4/0/0/0	3
wb5421-03	Modelling of Manufacturing Processes	0/0/0/2	3
wb5453-05	State of the Art in Material Removal Process	0/0/2/2	3
Total EC: compulsory courses (PT focus area)			20

Suggested elective courses: Production Technology focus area (PT) [1)]			
ae4-485	Manufacturing Engineering		3
ae4-786	Sheet-Metal Forming in AE industry		3
ae4-X01	Modern Topics in Materials Science		3
ae4-X04	Materials Selection in Mechanical Design		3
et4245wb	Electromechanical Systems		4
in2670	Database beheer		2

in4050tu	Java and Object-Oriented Design		6
in4073	Embedded RT Systems		6
MS3021	Metals Science	4/4/0/0	4
MS3421	Developments in Production and Processing	2/0/0/0	2
MS4011	Mechanical Properties	4/4/0/0	3
sc4070	Control Systems Lab	0/0/3/0	4
sc4150	Fuzzy Logic and Engineering Applications	0/0/3/0	3
wb1406-05	Experimental Mechanics	0/0/2/2	4
wb1418	Engineering Dynamics	2/2/0/0	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1443	Matlab in Engineering Mechanics	0/2/0/0	2
wb1444-05	Advanced Microelectronics Packaging	0/0/0/2	2
wb1445-05	Virtual Prototyping and Qualification of Microelectronics and Microsystems	0/0/2/0	3
wb1451-05	Engineering Mechanics Fundamentals	0/0/2/3	4
wb2428-03	Mechanical Design in Mechatronics	2/2/2/0	5
wb2441	Modelling Dynamic Systems for PMM	0/0/2/2	4
wb2454-05	Multiphysics Modelling using FEMLAB	0/0/2/0 of 0/0/0/2	4
wb3423-04	Modelling of Industrial Systems	2/0/0/0	3
wb5400	Tribology and Precision Machinery	0/0/2/2	4
wb5414-03	Design of Machines and Mechanisms	2/2/0/0	3
wb5430-05	Engineering Informatics	0/4/0/0	3
wb5431-05	Lifecycle Engineering	0/0/0/4	3
wm0516TU	Turning Technology into Business		6
wm0605tu	Business Economics for Engineers		4
wm….tu	Language courses (in consultation with study co-ordinator)		x
Total EC: elective courses (PT focus area)			17

[1] In consultation with your co-ordinator, you may suggest other courses not mentioned here.

1.5.4.2 MECHATRONICS FOCUS AREA (M)

- Advanced Mechatronics
  Prof. Jan van Eijk, tel. +31 (0)15 27 85396,
  e-mail J.vanEijk@tudelft.nl
- Mechatronics Design
  Vacancy, e-mail J.vanEijk@tudelft.nl
- Secretary: Ms. C. P. du Burck, tel. +31 (0)15 27 85733,
  e-mail c.p.duburck@tudelft.nl

The chairs of Mechatronics Design and Advanced Mechatronics both focus on the design of advanced machinery (wafer steppers, fast and precise production machines, microfactories, etc) and its modelling aspects. While Mechatronics Design concentrates more on innovating construction principles into new designs, Advanced Mechatronics is more concerned with the integration of control. As well as such objectives as miniaturisation and nanometre precision, both groups are working on challenging micrometric and nanometric-scale applications such micro-electromechanical systems (MEMS) and inkjet print heads.

Other activities, related to Tribology and Vehicle Mechatronics, form part of this work or are carried out in collaboration with others.

Both groups are strongly multidisciplinary, with the integration of mechanics, control, electronics and embedded-system software development playing an important role in their activities. On the workfloor, the Mechatronics student experiences this multidisciplinarity when they join a project teams in the second year of the MSc. Made up of post-doctoral researchers, PhD students and MSc students, these project teams work together on the same machinery but study different aspects of it. Depending on their particular interests, in this phase Mechatronics students have the opportunity to direct their studies and skills towards design and modelling, control, embedded system development, sensor and actuator electronics and MEMS applications.

The research projects within the groups are often carried out in collaboration

with industry (Philips, ASML, Océ, SKF, Assembleon, etc.) or international research institutions (University of Tokyo, University of Hokkaido, Osaka University and Keio University in Japan and the EPFL in Lausanne, Switzerland).

The inclusion of expertise on tribology in the groups provides opportunities to study and to conduct research on air lubrication and friction as applied in, for example, advanced bearing concepts for instance. Mechatronic bearings developed in the lab are based on electromagnetic levitation or active air lubrication.

In collaboration with DCSC, advanced control algorithms can be designed to optimise the speed and precision of precision machinery.

Another important field that can be studied is vehicle mechatronics. The topics here focus mainly on dynamics and control, but may also include design aspects (eg. designing and applying semi-active suspension elements).

Ongoing projects.
- Anti-roll actuators in vehicles, based on wheel-force sensors. (Smart Cars with DCSC).
- Reliable brake-by-wire.

And many Master's projects in the Automotive industry

Advanced Mechatronics focuses specifically on the development of high-performance servo systems, such as CD players, hard-disk drives and wafer steppers. Magnetic bearing systems are being developed for the use in the newest generation of high-performance tools.

Ongoing projects.
- High-precision magnetic bearing concepts for optical disc mastering.
- High-precision planar drives.
- Rapid pick-and-place machinery for micro-components.
- High-precision desktop machinery for combined high-speed milling and electro-discharge machining.
- Desktop machinery for haptic micro-assembly.

- Hybrid bearings for high-speed spindles (> 300,000 rpm).
- MEMS technology for dual-stage disk drives.
- MEMS technology for inkjet printing.

Student-exchange programmes exist between TU Delft and EPFL (Lausanne, Switzerland) and the University of Tokyo (Japan).

Career opportunities

Many graduates of this focus area find a warm welcome as mechatronics designers on multidisciplinary teams to develop new products at firms like Philips, ASML, Océ, SKF and Assembleon. Another option is to stay in research, working at a university, institute or commercial company. Some graduates join engineering consultancies and a small number even start their own businesses.

First-year courses: MSc Mechanical Engineering, PPM specialisation, M focus area			
Course code	Course name	Contact hours	EC
Compulsory courses (PPM specialisation)			
sc4021	Control Theory for PMM	4/0/0/0	4
wb1442	Introduction to Microsystems	2/2/0/0	3
wb1450-05	Mechanical Analysis for Engineering	3/2/0/0	4
wb2414	Mechatronics (design)	2/2/0/0	3
wb5434-05	Micro-assembly, Packaging and Testing	0/0/4/0	3
wb5450-05	Selected Topics in PME	0/0/0/2	1
wb5451-05	Attending student colloquia	1/1/1/1	1
wb5452-05	Introduction to PMM Laboratory	2/2/2/2	4
Total EC: compulsory courses (PPM specialisation)			23

Compulsory courses: Mechatronics focus area (M)			
wb1418	Engineering Dynamics	2/2/0/0	3
wb2303	Measurement Theory and Practice	0/0/2/2	3
wb2427	Predictive Modelling	0/0/4/0	3

wb2428-03	Mechanical Design in Mechatronics	2/2/2/0	5
wb5400	Tribology and Precision machinery	0/0/2/2	4
et4245wb	Electromechanical Systems		4
Total EC: compulsory courses (M focus area)			22

Suggested elective courses: Mechatronics focus area (M) [1)]			
ae4-485	Manufacturing Engineering		3
et4250	Integrated Circuit Technology		3
et4257	Silicon Sensors		3
id5171	Literature Research and Information Retrieval		2
in4073	Embedded RT Systems		6
SC4110	System Identification	0/0/4/4	5
tn2052	Electricity and Magnetism		5
wb1413-05	Multibody Dynamics B	0/0/2/2	4
wb1416	Numerical Methods for Dynamics	0/0/0/2	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1441	Engineering Optimisation 2	0/0/2/2	
wb1443	Matlab in Engineering Mechanics	0/2/0/0	2
wb2305	Digital Control	0/4/0/0	3
wb2402	Hydraulic Servosystems	2/2/0/0	3
wb2415	Robust Control	0/0/4/0	6
wb2421	Multivariable Control	0/4/0/0	6
wb2441	Modelling Dynamic Systems for PMM	0/0/2/2	4
wb2454-05	Multiphysics Modelling Using FEMLAB	0/0/2/0 of 0/0/0/2	4
wb3404A	Vehicle Dynamics A	0/0/2/2	3
wb5430-05	Engineering Informatics	0/4/0/0	3
wb5453-05	State of the Art in Material Removal Process	0/0/2/2	3

wm….tu	Language courses (in consultation with study co-ordinator)		x
Total EC: elective courses (M focus area)			15

[1)] In consultation with your co-ordinator, you may suggest other courses not mentioned here.

1.5.4.3 ENGINEERING MECHANICS FOCUS AREA (EM)

The Engineering Mechanics specialisation is supported by the following four disciplines (listed alphabetically).

Engineering Dynamics (EM-ED):

- Prof. D. J. Rixen, tel. +31 (0)15 27 81523, e-mail d.j.rixen@tudelft.nl
- Secretary: Ms C. P. du Burck, tel. +31 (0)15 27 85733, e-mail c.p.duburck@tudelft.nl

Mechanics of Materials (EM-MM)1:

- Prof. L. J. Ernst, tel. +31 (0)15 27 86519, e-mail l.j.ernst@tudelft.nl
- Secretary: Ms C. P. du Burck, tel. +31 (0)15 27 85733, e-mail c.p.duburck@tudelft.nl

Microsystems Reliability (EM-MR)1:

- Prof. G. Q. Zhang, tel. +31 (0)15 27 82704, e-mail g.q.zhang@tudelft.nl
- Secretary: Ms C. P. du Burck, tel. +31 (0)15 27 85733, e-mail c.p.duburck@tudelft.nl.

Structural Optimisation and Computational Mechanics (EM-SOCM):

- Prof. A. van Keulen, tel. +31 (0)15 27 86515, e-mail F.vanKeulen@tudelft.nl
- Secretary: Ms M. C. Stolker, tel. +31 (0)15 27 86513, e-mail m.c.stolker@tudelft.nl

Engineering Mechanics studies the foundations of mechanical engineering. Broadly speaking, that means theoretical and experimental analysis of the statics and dynamics of structures and mechanical systems (loads and performance), the material properties of system components, the automation of design and the optimisation of mechanical system components.

The Engineering Mechanics focus area focuses on understanding of the characteristics of mechanical systems rather than on operational aspects. Since Engineering Mechanics is a core field for mechanical engineers, graduates of this focus area are often sought by industry as members – and future leaders – of teams working energetically on mechanical innovations.

Whilst aiming to cover the field of Engineering Mechanics in general, the focus area does focus on four specific disciplines within that domain: (i) Engineering Dynamics, (ii) Mechanics of Materials, (iii) Microsystems Reliability and (iv) Structural Optimisation and Computational Mechanics. The last three of these are combined as Fundamentals of Microsystems.

The initial compulsory courses give MSc students a broad overview of the fundamentals of Engineering Mechanics. They may then elect either to focus in depth on one of the three above disciplines or to work in more than one of them, thereby benefiting from the synergy of working in multiple fields. Or they may choose a theme combining one or more of the above disciplines with one from another focus area. In other words, there is considerable flexibility in devising a preferred programme of study.

This flexibility is important because it caters to individual interests and prepares the student for a modern engineering career, in which one must always be flexible in terms of projects handled and jobs pursued.

Below we describe typical activities in each of the Engineering Mechanics disciplines.

Engineering Dynamics
Focus on the dynamic behaviour of structures and mechanisms, to help determine their characteristics and the room for improvement of their dynamic performance.

Courses and projects cover the fundamentals of structural vibrations in mechanical and multibody systems. Research involves both computer simulations and experimental investigations in the dynamics laboratory. In addition to pure mechanical systems, attention is also paid to so-called multi-physics systems displaying interaction with fluid flow and with electromechanical fields. Research projects cover a broad spectrum, with an emphasis on the fundamentals of high-performance dynamic systems.

Here are some specific examples from across the field of dynamics.
- Passive suppression of vibration in key components of a wafer stepper, at ASML.
- Shock response of small electronic equipment (eg. MP3 players), at Philips.
- Vibrations on cold rolling mills, at CORUS.
- Mechanical performance of downhole components of oil drill strings, at Shell.
- Multibody dynamics analysis of a human knee prothesis, in house.
- Biodynamic identification of sacro-iliatic joints with ultrasound measurements and modelling, in house.
- Design and analysis of driver's seat vibration attenuation for heavy-duty vehicles, at University of Stellenbosch.
- Efficient hybrid modelling of the vibrations of coupled automobile components, at BMW.
- Influence of vibrations on performance of a high-performance optical test bench, at TNO-TPD.
- Dynamic load analysis of satellites coupled with an Ariane 5 launcher, at Estec.
- Modelling and controller design for dynamic operation of a large system for structural testing (a 20-tonne hydraulic shaker), at Estec.
- Stability of offshore components, in house.
- Ground vibrations caused by deep-epicentre earthquakes, at Ho Chi Minh University and in house.
- Modelling and experimental verification of the dynamics of a musical instrument, in house.
- Modelling and analysis of the dynamics of small manoeuvring submarine vehicles, at Princeton University and in house.
- Computational aspects in the analysis of interaction between a rapidly moving flexible structure and its flexible support (train wheelset on

railway track), at DLR.
- Computational aspects of multiphysics phenomena in microsystems, in house.

Fundamentals of Microsystems

The design of mechanical systems requires a thorough fundamental understanding of their behaviour and demands modelling tools. The main foci of this discipline are modelling, experimental characterisation and validation, and the optimisation of mechanical systems. The modelling involves the development of adequate material models, including material identification and model validation. But it also deals with multidisciplinary models and fast reanalysis, which are mandatory for design purposes. Once models are available, the route towards automated design (optimisation) is opened. The research activities centre around several applications: (i) microsystems, (ii) biomechanical systems and (iii) aerospace structures. It should be emphasised that the microsystems take the most prominent position. Here are some typical examples of ongoing projects.

- Reliability of microsystems (Philips).
- Curing of electronic materials (Philips)
- Buckling of thin layers (Philips Research)
- Fast reanalysis (Airbus).
- Topology optimisation of microsystems (in house, SNU Korea, Dimes).
- Modelling of surface effects (Philips, Dimes).
- Model updating using ground vibration tests (NLR, Airbus).
- Design of microgrippers using shape memory alloys.
- Design of electrostatic actuators.
- Bone ingrowth simulation for shoulder endoprosthesis (EUR, LUMC).

First-year courses: MSc Mechanical Engineering, PPM specialisation, EM focus area			
Course code	Course name	Contact hours	EC
Compulsory courses (PPM specialisation)			
sc4021	Control Theory for PMM	4/0/0/0	4
wb1442	Introduction to Microsystems	2/2/0/0	3
wb1450-05	Mechanical Analysis for Engineering	3/2/0/0	4
wb2414	Mechatronics (design)	2/2/0/0	3
wb5434-05	Micro-assembly, Packaging and Testing	0/0/4/0	3
wb5450-05	Selected Topics in PME	0/0/0/2	1
wb5451-05	Attending student colloquia	1/1/1/1	1
wb5452-05	Introduction to PMM Laboratory	2/2/2/2	4
Total EC: compulsory courses (PPM specialisation)			23

Compulsory courses: Engineering Mechanics focus area (EM)			
wb1406-05	Experimental Mechanics	0/0/2/2	4
wb1418	Engineering Dynamics	2/2/0/0	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1451-05	Fundamentals of Engineering Mechanics	0/0/2/3	4
Total EC: compulsory courses (EM focus area)			14

Suggested elective courses: Engineering focus area Mechanics (EM) [1)]			
ae4-153	Advanced Numerical Techniques for Fluid Flow and Structural Engineering		3
ae4-684	Fibre-Reinforced Materials		3
ae4-900	Continuum Mechanics		3
ae4-930	Aeroelasticity		3
ct5142	Non-linear Numerical Mechanics		3
ct5145wb	Random Vibrations		3
et4245wb	Electromechanical Systems		3
et4257	Silicon Sensors		3
id5211	Computer Visualisation		3
SC4110	System Identification	0/0/4/4	5
tm2721-da	Physical and Mechanical Properties A	4/0/0/0	3
tm2721-db	Physical and Mechanical Properties B	0/0/4/4	6
wb1310	Multibody Dynamics A	0/0/0/4+P	3
wb1405A	Stability of Thin-Walled Constructions	0/0/4/2	4

wb1408a	Shell Structures – Introduction	0/0/4/0	3
wb1408b	Shell Structures – Advanced	0/4/2/0	5
wb1409	Elasticity Theory	2/2/0/0	3
wb1412	Linear and Non-Linear Vibrations in Mechanical Systems	0/0/2/2	3
wb1413-05	Multibody Dynamics B	0/0/2/2	4
wb1416	Numerical Methods for Dynamics	0/0/0/2	3
wb1417-05	Fluid-Structure Interaction	0/0/2/2	4
wb1433-04	Thermomechanical Modelling and Characterisation of Polymers	0/0/3/0	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1441	Engineering Optimisation 2	0/0/2/2	3
wb1443	Matlab in Engineering Mechanics	0/2/0/0	2
wb1444-05	Advanced Microelectronics Packaging	0/0/0/2	2
wb1445-05	Virtual Prototyping and Qualification of Microelectronics and Microsystems	0/0/2/0	3
wb1481lr	Dynamics and Control of Space Systems	0/0/4/0	4
wb2303	Measurement Theory and Practice	0/0/2/2	3
wb2308	Biomedical Engineering Design	2/0/0/0	4
wb2402	Hydraulic Servosystems	2/2/0/0	3
wb2408	Physiological Systems	0/4/0/0	3
wb2427	Predictive Modelling	0/0/4/0	3
wb2428-03	Mechanical Design in Mechatronics	2/2/2/0	5
wb2431	Bone Mechanics and Implants	0/2/2/0	3
wb2432	Biomechatronics	0/0/2/2	4
wb2441	Modelling Dynamic Systems for PMM	0/0/2/2	4
wb2454-05	Multiphysics Modelling Using FEMLAB	0/0/2/0 of 0/0/0/2	4
wb3404A	Vehicle Dynamics A	0/0/2/2	3
wb5400	Tribology and Precision Machinery	0/0/2/2	3
wb5414-03	Design of Machines and Mechanisms	2/2/0/0	3
wb5453-05	State of the Art in Material Removal Process	0/0/2/2	3
wi4007tu	Fourier and Laplace Transforms		3
wi4011	Numerical Methods for Large Algebraic Systems		3
wi4014tu	Numerical Analysis C2		6
WI4145TU	Computational Science and Engineering		6
wm0605tu	Business Economics for Engineers		4
wm….tu	Language courses (in consultation with the study co-ordinator)		x
Total EC: elective courses (EM focus area)			23

1) In consultation with your co-ordinator, you may suggest other courses not mentioned here.

Note to readers

This document was compiled in May 2006. Any changes introduced since that date are not included in it. Check the PME website www.pme.tudelft.nl/pmm for the latest and more detailed information on the PMM specialisation.

1.5.5. BIOMECHANICAL DESIGN SPECIALISATION (BMD)

- BMD specialisation co-ordinator: Dr J. L. Herder, tel. +31 (0)15 27 84913, e-mail j.l.herder@3me.tudelft.nl

Introduction

Biomechanical Design (BMD) is one of five specialisations within MSc Mechanical Engineering. It is rooted in the Department of Biomechanical Engineering, where students receive advanced education in the design and engineering of robotic devices, mechatronic design, control engineering and biological principles.

Biomechanical systems are technical systems designed to interact with biological systems, or designed following the principles of biological systems. Examples are telemanipulation systems, such as those used in surgical robots, in space and in the off-shore industry, where a human controls a master robot whilst a slave robot mimics these actions. Other examples of biologically inspired design are endoscopes with the flexibility and steerability of an octopus tentacle, humanoid robots walking as humans do and intelligently collaborating robots using local interactive information exchange, as humans do.

Focus areas

- Biorobotics (BR).
- Biocompatible Design (BCD).
- Intelligent Mechanical Systems (IMS)

1.5.5.1. BIOROBOTICS FOCUS AREA (BR)

Biorobotics emphasises the analysis and design of robots meant to interact physically with humans. Topics include haptic interfaces and walking robotics. A haptic interface is a controlling device for a slave robot or a virtual environment, say, which provides the human operator with force feedback giving additional information about the environment, real or virtual, so as to improve task performance. Another topic is bipedal humanoid robots, which use the same strategy as human beings to walk: making optimum use of the passive dynamic properties of the legs. These robots are intended to assist in a human environment ("service robots"), to study human walking or for the entertainment industry. Students in this focus area are encouraged to take robotics-related courses from other departments, such as Robot Vision or Artificial Intelligence.

1.5.5.2. BIOCOMPATIBLE DESIGN FOCUS AREA (BCD)

Probably the greatest diversity of mechanical designs is found in nature. For each challenge posed by the – often hostile – environment, a wealth of solutions to cope with the threats has evolved. In the Biocompatible Design focus area, an extensive excursion into biology provides students with the inspiration to search for uncommon and innovative solutions to what are often uncommon challenges. Numerous applications exist in such fields as medical intervention (minimally invasive surgery, endoscopy), rehabilitation technology, aerospace and the assembly of microsystems.
In addition to this bio-inspired design, you will also be trained to design mechanical systems to fit naturally to the behaviour of biological systems, in particular humans. Rather than adapting existing technology, many applications require the development of totally new technology such as rolling contact joints, balancers, pneumatic actuators, stiffness control and lightweight systems. These applications include rehabilitation and medical technology, but also such things as industrial robotic manipulators in agriculture.

1.5.5.3. INTELLIGENT MECHANICAL SYSTEMS FOCUS AREA (IMS)

Contemporary machines are required to deliver superior performance in terms of function, cost and quality at every stage in their lifecycle, not only in operations but also in maintenance and even at the end of their life. They must be easy to use, intelligent in their interaction with humans, robust and fault-tolerant, easy to maintain even if a fault happens, ready for reconfiguration to cope with increasingly changeable situations and sustainable from the environmental point of view. This requires machines to be designed and built based on innovative design principles, in particular by learning from biological systems and by embedding intelligence. Applications of these principles include industrial machinery, transportation machines, office equipment, home appliances or any mechatronics products.

For example, we can think about a new generation of production robots with some basic intelligence to communicate with other robots and to decide for themselves what will be the best strategy to cope with demands on the production line. Students learn to structure data processing between multiple robots in order to optimise their "team performance", inspired by biological examples like ant colonies. Information acquisition, reasoning-based decision making and active control of intelligent mechanical systems are key features of this focus area.

This can be extended to supervisory control of complex systems. This topic of human-machine interaction is part of the IMS focus area.

Relationship with MSc Biomedical Engineering

Students in the Department of Biomechanical Engineering can choose between two MSc programmes: Biomedical Engineering, with focus areas in Medical Instruments & Medical Safety and Biomechatronics, and the Biomechanical Design specialisation of the MSc Mechanical Engineering, with focus areas in Biorobotics, Biocompatible Design and Intelligent Mechanical Systems. Those studying Biomedical Engineering (BME) find that 50 per cent of their course is devoted to the biomedical field and that they are being educated for design and/or research work in the medical industry or hospitals; on the other hand, those taking Biomechanical Design (BMD) have more courses in the field of mechatronics: mechanics, control engineering and the design of mechanisms. Moreover, BME students typically take some courses in the biomedical domain, in order to acquire knowledge about the biological systems with which "their" technical systems will interact with and to gain inspiration from nature.

Another difference is that BME students' graduate projects have one supervisor from the TU Delft and one from a medical partner institute.

Successful BME students are awarded an MSc in Biomedical Engineering, with their chosen focus area (Medical Instruments and Medical Safety or Biomechatronics) listed on the certificate. BMD graduates receive an MSc in Mechanical Engineering, on which are listed both the specialisation (Biomechanical Design) and the focus area taken (Biorobotics, Biocompatible Design or Intelligent Mechanical Systems).

CURRICULUM

Course code	Course name	Contact hours	EC	focus area		
				BR	BCD	IMS
sc4020	Control Theory	4/0/0/0	6	o	o	o
wb2306	The Human Controller	0/0/0/4	3	o	o	o
wb2404	Man-Machine Systems	0/4/0/0	4	o	o	o
wb2433-03	Humanoid Robots	4/0/0/0	3	o	o	o
wb5435-05	Machine Intelligence	0/0/4/0	3	o	o	o
sc4070	Control Systems Laboratory	0/0/4/0	4	o		o
wb1413-04	Multibody Dynamics B	0/0/2/2	4	o	r	
wb2303	Measurement Theory and Practice	0/0/2/2	3	o	r	
wb2407	Human Movement Control	0/4/0/0	4	o	r	
wbp202	Haptic System Design	No lectures	4	o	o	r
wb1310	Multibody Dynamics A	0/0/0/2	3		o	r
wb2308	Biomechanical Engineering Design	0/2/0/0	4	r	o	
wb2408	Physiological Systems	0/4/0/0	3		o	
wb2436-05	Bio-Inspired Design	0/0/4/0	3	r	o	o
wb5414-03	Design of Machines and Mechanisms	2/2/0/0	3			o
wb5430-05	Engineering Informatics	0/4/0/0	3	r		o
wb5431-05	Lifecycle Engineering	0/0/0/4	3	r		o
et4085	Image Processing		3	r		
et4245wb	Electromechanical systems		4	e	e	e
id4125	Product Lifecycle Engineering & Design A		3			r
in4010TU	Artificial Intelligence		6	r		
in4073	Embedded Real-Time Systems		6	r		r
sc4060	Predictive Control Systems	0/0/3/0	4	e	e	e
sc4080	Knowledge-Based Control	0/0/2/0	3	r		r
sc4090	Optimisation in Systems and Control	4/0/0/0	3	e	e	e
sc4100	Mechatronic Design	2/2/0/0	3	r		r

sc4110	System Identification	0/0/2/2	5	e	e	e
sc4120	Special Topics in Signals, System and Control	0/0/0/2	3	e	e	e
sc4150	Fuzzy Logic & Engineering Applications	3/0/0/0	3	r		r
tn3534	Pattern Recognition	0/0/4/0	3	e	e	e
tn3541	Data Analysis	4/0/0/0	3	e	e	e
wb1406	Experimental Mechanics	0/0/2/2	3	e	e	e
wb1416	Numerical Methods in Engineering Dynamics	0/0/2/2	3	e	e	e
wb1418	Engineering Dynamics	2/2/0/0	3	e	e	e
wb1419	Engineering Dynamics and Mechanisms	2/2/0/0	4	e	e	e
wb1440	Engineering Optimisation	2/2/0/0	3	e	e	e
wb1442	Introduction to Microsystems	2/2/0/0	3	e	e	e
wb1444-05	Advanced Microelectronics Packaging	0/0/0/4	2	e	e	e
wb1445-05	Virtual Prototyping and Qualification of Microelectronics and Microsystems	0/0/4/0	3	e	e	e
wb2301	System Identification & Parameter Estimation	0/0/2/2	7	r	r	r
wb2305	Digital Control Systems	0/4/0/0	3	e	e	e
wb2400	Process Control	0/0/2/2	3			r
wb2402	Hydraulic Systems	2/2/0/0	3	e	e	e
wb2413-04	Instrumentation in the Process Industry	0/0/0/4	2			r
wb2414	Mechatronics	2/2/0/0	3	e	e	e
wb2415	Robuust regelen	0/0/4/0	6	e	e	e
wb2416	Lineaire matrixongelijkheden regel-theorie	0/0/0/4	6	e	e	e
wb2422	Modelling 2	0/0/4/0	6	e	e	e
wb2427	Predictive Modelling	0/0/4/0	3	e	e	e
wb2428-03	Mechanical Design in Mechatronics	2/2/2/0	5	r	r	r
wb2432	Biomechatronics	0/0/2/2	4	r	r	
wb2435-03	Surgical Instruments & Medical Safety	2/0/0/0	2		r	
wb3417-04	Discrete Systems	2/2/0/0	5	r		
Compulsory courses				38	36	35

Elective courses to be selected	**22**	**24**	**25**
Total courses	**60**	**60**	**60**
Total projects (assignments/thesis)	**60**	**60**	**60**
Total EC	**120**	**120**	**120**

o = compulsory courses.

r = recommended courses.

e = elective courses.

1.5.6 SOLID AND FLUID MECHANICS SPECIALISATION (SFM)

- Specialisation co-ordinator: Dr B. J. Boersma, tel. +31 (0)15 27 87979, e-mail b.j.boersma@3me.tudelft.nl

The design, modelling and control of most practical structures and systems rely on either solid or fluid mechanics. And in cases of fluid-structure interaction, both are needed. Prompted by rapid developments in computer and information technology, in recent decades attention has been shifting away from analytical approaches and towards numerical models and techniques. For these reasons, mechanics and fluid dynamics – and their computational variants – are now keystones in many engineering disciplines: aeronautics, civil engineering, mechanical engineering, bioengineering and so on. Obviously, new theories and models require rigorous experimental validation. The Solid and Fluid Mechanics specialisation of MSc Mechanical Engineering is a two-year study devoted to the fundamentals of contemporary mechanics. A variety of courses address such issues as the formulation and fundamentals of governing continuum theories, numerical solution procedures and discretisation techniques. Solid and Fluid Mechanics provides an excellent starting point for those aiming at a research career in industry or academia. And those wishing to pursue advanced engineering will find a solid basis for further specialisation.

The programme features an initial compulsory common curriculum and then four focus areas.

- Fluid Mechanics (FM).
- Engineering Dynamics (ED).
- Mechanics of Materials (MM).
- Structural Optimisation & Computational Mechanics (SO).

1.5.6.1. FLUID MECHANICS FOCUS AREA (FM)

- Prof. J. Westerweel, tel. +31 (0)15 27 86887, e-mail j.westerweel@wbmt.tudelft.nl
- Secretary: Ms. H. J. van der Brugge, tel. +31 (0)15 27 82904, e-mail h.j.vanderbrugge@wbmt.tudelft.nl

The Fluid Mechanics focus area provides training in the fundamentals of incompressible fluid flow. Particular attention is paid to turbulence and multi-phase flow, since these are relevant to so many industrial and environmental applications. With a view to modern technology, much emphasis is placed on numerical fluid dynamics (NFD) and its use in solving various practical problems. The Fluid Mechanics group also carries out extensive research on new developments in the application of numerical tools to fluid mechanics, particularly with respect to the simulation of turbulence. Since fluid mechanics is a strongly non-linear physical phenomenon, we cannot do without experiments in this field. For this reason, most of the numerical work is combined with experimental research emphasising the use of new measuring techniques. Consequently, the student is trained in all aspects of modern fluid mechanics in both classroom and research environments.

1.5.6.2. ENGINEERING DYNAMICS FOCUS AREA (ED)

- Prof. D. J. Rixen, tel. +31 (0)15 27 81523, e-mail d.j.rixen@wbmt.tudelft.nl
- Secretary: Ms C. P. du Burck, tel. +31 (0)15 27 85733, e-mail c.p.duburck@wbmt.tudelft.nl

Central to the research and teaching of the Engineering Dynamics group is the dynamic behaviour of structures and mechanisms. Students learn the fundamentals of structural vibrations and multibody dynamics, and to use the basic tools needed to handle such problems. Structural dynamics and its coupling with fluid or electromagnetic fields have applications in very many domains, including machine design, biomechanics, mechatronics and aerospace. Education and research in Engineering Dynamics involve computer simulations as well as experimental testing and the measurement of dynamic properties in the laboratory. MSc theses are related either to research topics currently being addressed by the group or to subjects in which students have a personal interest. There are also plenty opportunities to prepare a thesis in collaboration with firms like Philips, Shell, Corus, ASML or BMW.

1.5.6.3. MECHANICS OF MATERIALS FOCUS AREA (MM)

- Prof. L. J. Ernst, tel. +31 (0)15 27 86519, e-mail l.j.ernst@wbmt.tudelft.nl
- Dr Kaspar M. B. Jansen, tel. +31 (0)15 27 86905, e-mail k.m.b.jansen@wbmt.tudelft.nl
- Secretary: Ms C. P. du Burck, tel. +31 (0)15 27 85733, e-mail c.p.duburck@wbmt.tudelft.nl

The continuous improvement of mechanical products and processes requires a flexible design method. And that demands a profound understanding, during the design phase, into the mechanical properties relevant to production and use. Engineering Mechanics offers a variety of analytical, numerical and experimental methods to gain or improve that understanding.

One recent development in flexible design is so-called "virtual prototyping". During the design phase, the steps in the production process and the resulting mechanical product properties are established using simulations. The design can then be improved step by step, each adaptation resulting into an alternative virtual prototype. Combined with proper optimisation, this procedure can result in efficient and fast product development with the reasonable probability that the mechanical properties of the "real" prototype, when it is finally constructed, will meet the specifications set. This is why virtual (simulation-based) prototyping has begun to attract considerable commercial and academic attention in recent year. The process draws in a variety of elements, including the mechanical modelling of material behaviour, numerical simulation, the design of appropriate optimisation tools and appropriate experimental verification techniques. Education and research in the Mechanics of Materials focus area concentrates on these, with a particular focus on the experimental characterisation and modelling of process-dependent material behaviour, the simulation of production steps and related mechanical products properties and the experimental verification of simulation results.

Reliability of microelectronics and microsystems

Some of the most challenging fields of application concern the production-related reliability of microelectronics and microsystems. Because of continuing miniaturisation in this area, new concepts in mechanics and new experimental methods are being developed and applied all the time. Many Master's theses in this focus area are related to these challenges, offering opportunities to co-operate with industrial research partners like Philips, Fraunhofer IZM, IMEC, TNO, Thales, Siemens, Kitron, Motorola, ICI and DSM. Key subjects of MSc research work include…

- Typical failure modes in microelectronics and microsystems, related to design and production.
- Experimental mechanics focusing on materials characterisation and modelling, and to the verification of product properties.
- Simulation of microelectronics and microsystem behaviour during and after production.

1.5.6.4. STRUCTURAL OPTIMISATION AND COMPUTATIONAL MECHANICS FOCUS AREA (SO)

- Prof. A. van Keulen, tel. +31 (0)15 27 86515, e-mail a.vankeulen@wbmt.tudelft.nl
- Secretary: Ms M. C. Stolker, tel. +31 (0)15 27 86513, e-mail m.c.stolker@wbmt.tudelft.nl

Recent developments in computer technology have opened up new potential for automated design and optimisation. This requires a solid understanding and knowledge of computational mechanics, as well as optimisation. And other disciplines are nearly always involved as well: production, electrical engineering, material sciences and so on. The MSc focus area Structural Optimisation and Computational Mechanics includes lectures on the fundamentals of mechanics, numerical modelling and optimisation, whilst the research programme currently covers composite structures, micro-electromechanical systems (MEMS) and biomedical applications. Typically, MSc theses are related to these fields and may be carried out in collaboration with other research institutes or industry.

Compulsory courses: Solid and Fluid Mechanics specialisation

Course code	Course name	Contact hours	EC
ae4-900	Continuum Mechanics		4
ct5142	Computational Methods in Non-Linear Mechanics		3
wb1409	Theory of Elasticity	2/2/0/0	3
wb1419	Engineering Dynamics and Mechanisms	2/3/0/0	4
wb1427-03	Advanced Fluid Mechanics A	2/2/0/0	5
wb1428	Computational Fluid Dynamics	0/0/2/2	3
Total EC			22

Recommended elective focus area courses (≥ 27 EC)

Course code	Course name	Lecture hours	EC
ae4-30	Aero-Elasticity		3
ae4-140	Gas Dynamics I		3
ae4-141	Gas Dynamics II		3
ap3181D	Multiphase Flow		6
ctme5145	Random Vibrations		3
tn3713	Advanced Thermodynamics		6
tn3733	Turbulent Reacting Flows		6
tn3753	Transport Phenomena II		6
wb1310	Multibody Dynamics A	0/0/0/4	3
wb1402a-04	Plates and Shells	0/4/2/0	5
wb1405a	Buckling Analysis	0/0/4/2	4
wb1406	Experimental Mechanics	0/0/2/2	3
wb1408A	Shell Structures – Introduction	0/0/4/0	3
wb1408B	Shell Structures – Advanced	0/4/2/0	5
wb1412	Linear and Non-Linear Vibrations in Mechanical Systems	0/0/2/2	3
wb1413-04	Multibody Dynamics B	0/0/2/2	4
wb1416	Computational Engineering Mechanics	0/0/2/2	3
wb1417	Fluid-Structure Interaction	0/0/0/2	2
wb1424atu	Turbulence A	0/0/2/2	6
wb1424b	Advanced Turbulence	0/0/2/2	3
wb1429-03	Microfluidics	0/0/2/2	3
wb1433-04	Thermomechanical Modelling & Characteristics of Polymers	0/0/3/0	3
wb1440	Engineering Optimisation	2/2/0/0	3
wb1441	Optimisation II	0/0/2/2	3
wb1444-05	Advanced Microelectronics Packaging	0/0/0/4	2
wb1445-05	Virtual Prototyping and Qualification of Microelectronics and Microsystems	0/0/4/0	3
wb2303	Measurement Theory and Practice	2/2/0/0	3
wb2414	Mechatronics	2/2/0/0	3
wb5414-03	Design of Machines and Mechanisms	2/2/0/0	3
wi3001	Numerical Methods for Partial Differential Equations		6
wi4006	Special Functions		6
wi4008	Complex Analysis		4
wi4010	Advanced Course on Numerical Linear Algebra		6
wi4011	Numerical Fluid Dynamics		6
wi4014tu	Numerical Analysis C2		6
wm0605tu	Business Economics for Engineers		4
wm0621tu	Innovation Management		3

Compulsory courses	22 EC
Elective courses	28 EC
Assignments and projects	70 EC
Total	120 EC

1.5.7 ANNOTATIONS

As an addition to the focus area programme there are two annotations, to broaden the student's knowledge on a certain subject. After completing such an annotation, the student gets a supplement to the MSc degree which declares a more than average knowledge on that subject. These annotations are:

a) Technical Marketing
b) Sustainable Development

The study programme including an annotation has to comply with the requirements of paragraph 1.2 (120 EC).

a) Annotation Technical Marketing

The responsible lecturer for Technical Marketing is prof. mr. dr. Sicco C.Santema, tel. +31 (0)15 27 83076

The Technical Marketing annotation offers students the possibility to gain knowledge and skills in a more commercial direction. The study programme is meant for students who want to prepare themselves for a technical commercial function (sales, marketing) in their area. The study programme will be determined in consultation with the student, the lecturer responsible for the focus area and the lecturer responsible for Technical Marketing, Prof. mr. dr. ir. Sicco S. Santema. The marketing component in the study programme consists of at least 16 EC marketing courses and 16 EC of the MSc thesis should be devoted to marketing aspects. This means that a significant part of the elective courses has to be used for technical marketing. The marketing content of the MSc thesis complement the chosen focus area. The thesis should provide a synthesis between technology and marketing. Normally this part involves a marketing research study for products which still have to be developed, or a market introduction study for products already developed but not yet introduced into the market. At the end of the MSc thesis integration between marketing and technology will take place. This will result in a synthesis report. Both the lecturer of the chosen focus area and a technical marketing lecturer will act as supervisors.

Compulsory courses annotation Technical Marketing

Course code	Course name	Lecture hours	EC
ID4141	Consumer research	0/0/3/3	6
ID5131	Business marketing for engineers	0/0/2/0	3
IDE511	Integral aspect of business marketing/ E-business Design	0/0/0/4	3
		Total	12

Elective courses annotation Technical Marketing (at least 3 EC)

Course code	Course name	Lecture hours	EC
wm0720	Business law A / Company law	0/0/4/0	3
wm0115	Conflict handling and negotiation	0/3/0/0	2

Other courses in consultation with the Technical Marketing coordinator and the lecturer of the chosen focus area.

b) Annotation "Sustainable Development" (SD)

SD Coordinator
Prof.dr. A.H.M. Verkooijen
Tel: +31 (0)15 27 86687
E-mail: A.H.M.Verkooijen@3me.TUDelft.nl

Secretary
Mrs J.M.A. Ammerlaan
Tel: +31 (0)15 27 86734
E-mail: J.M.A.Ammerlaan@3me.TUDelft.nl

This certificate can be obtained as an addition to the SPET focus areas. In order to obtain the certificate, the student must satisfy 3 requirements:

1. Colloquium: A two-week seminar during which students work in interdisciplinary groups and wok on topical sustainability issues and approaches (4 EC). Sociotechnological scenarios and actual development around societal

aspects and the role of technology are central issues during this course. The interdisciplinary colloquium, consisting of two weeks work, is planned twice a year; in April and in October. There is room for maximum 20 students therefore students must sign up in time. For registration please contact the secretariat of Education in Sustainable Development (ODO)
Tel: +31 (0)15 27 83791
E-mail: A.T.M.Dokkuma-tenDam@tbm.TUDelft.nl or
K.H.J.vanDuyn-Derwort@tbm.TUDelft.nl

2. Elective courses package: Students must choose a balanced package of at least two 'Sustainable Development' related courses (a total of 5 EC) in two clusters (minimum 2 EC per cluster). These clusters are: Design, Analysis and Tools (Cluster A) and Management, Policy and Society (Cluster B). The Coordinator (SD referent) advises students to choose a balanced package of elective courses.

3. Sustainability issues in the Final Project: students are asked to incorporate sustainability issues specific to their disciplines in their graduation project. The SD Coordinator evaluates the graduation project by assessing how aspects of Sustainable Development are treated. The Coordinator evaluates the project before the beginning and after completion as for the way SD has included in the problem definition, in the actual project development and in the conclusion. The SD Coordinator advises the graduation committee. The professor supervising the final project remains primarily responsible for the general evaluation of the work. The credits necessary to obtain the SD certificate (Forms for the additional certificate) are summarized as follows:

Colloquium (wm0922tu)	4 EC
Compulsory sustainability courses	6 EC
Elective courses	5 EC
Final project	30 EC
Total	**45 EC**

1.6 ENROLLING FOR COURSES AND TESTS

Usually it is necessary to enrol for modules and tests.

Modules

Students can enrol for specific modules through Blackboard. Most of the communication between lecturer and students runs via Blackboard announcements. Exchange of information, assignments and reports often takes place via Blackboard also.

Tests

Enrolling for tests is compulsory and can be done at the TAS site (Tentamen Aanmeld Systeem www.tas.tudelft.nl). This should be done two weeks before the test takes place at the latest, otherwise the test will not be accounted for by the lecturer. If a student has enrolled, but decided not to do the test, the student must cancel this at least one week before the test takes place.

1.7 PASS RULES AND CRITERIA FOR 'HONOURS DEGREE'

1.7 PASS RULES AND CRITERIA FOR 'CUM LAUDE'

Pass rules

To pass a course or assignment, a grade of at least 6 is necessary. It is possible to pass the MSc examination with one grade of 5. The grades are rounded off to the nearest integer.

Examination

On completing the programme, the student should apply for the Master's examination by means of a form, available from the Education Support Staff.

'Cum laude'

At the discretion of the Board of Examiners, a candidate for the Master's degree can receive the designation "cum laude" if he or she meets the following conditions:

a) the mark awarded to the components specified in the Master's examination implementation procedures shall average no less than 8,

excluding the Master's Thesis in a list that contains no marks below 6;
b) the candidate concerned shall have completed the Master's degree programme in no more than three years;
c) the mark awarded for the thesis project shall be no less than 9;
d) the examiner of the graduation assignment shall have submitted a proposal for the award of "cum laude".

This is part of the "Regulations and guidelines for the Board of Examiners", appendix 6.1 of this study guide.

1.8 HONOURS TRACK

For excellent students it is possible to follow an honours track for their programme. An honours track is a special individual programme, in addition to the regular Master's programme, of 30 EC (840 hours) and is related to Materials Science and Engineering and / or to the role of technology within society. The extra programme has to be completed during the Master's programme of the student. Students who have successfully completed their honours track receive a special certificate from the university. Students who have finished the Bachelor's programme with a weighted averaged mark of 7.5 or higher and students who have shown an excellent performance during the first semester (no fails and weighted averaged mark 7.5 or higher), are eligible for following the honours track in their Master's programme. The Director of Education is responsible for the programme of each individual honours track.

1.9 STUDY AND INTERNSHIP ABROAD

Study abroad offers a lot of attractive prospects. You become acquainted with a different (organisational) culture, a different university life and a different educational system. Besides you expand your personal network, you learn to live within a foreign environment, and you improve your knowledge of languages. To put it briefly: a period of study abroad will make a valuable contribution to your personal education and you will draw much benefit from it during your search for a permanent job.

You can make use of one of many exchange agreements with European and non-European universities for your study at a foreign university. Within such an agreement you do not pay the foreign university any tuition fee. In addition to this, grants are available for financing the additional expenses for staying abroad. For initial information on studying abroad you are advised to visit the Back Office International Programmes of the Student Facility Centre. Much documentation about study abroad is available from this Centre, like information on all universities with which exchange agreements exist, possibilities of financing, and travel reports from students. Information is also available on the website: www.sfc.tudelft.nl

If you have a clear idea about where you want to go to, you can ask the Coordinator for International Exchange for advice about your programme at the foreign university and about the recognition of your results at the host university. Your graduation professor will judge your work afterwards according to the rules you agreed upon, prior to departure. The foreign programme should at least contribute 12 EC to the Master's programme. To arrange everything you have to do a lot yourself. Therefore you have to take a preparation period into account of preferably a year, but at least half a year.

Internship

Usually an internship is arranged via one of the staff members of the department. In addition to this you can visit the Information Centre of the Student Facility Centre (see above). They offer a lot of information, not only on a large number of companies abroad, but also on finance-related affairs, working permits, visa, etc. Additional information is available from the website: www.sfc.tudelft.nl

International Coordinator 3mE
Mrs M.P.I. Toppenberg
Room 8C, ground floor
Mekelweg 2
2628 CD Delft
Tel:: +31 (0)15 27 86959
Fax.: +31 (0)15 27 88340
E-mail: m.p.i.toppenberg@tudelft.nl

2 Organisation

2.1 FACULTY

The faculty 3mE offers the study programmes Biomedical Engineering (BME), Materials Science and Engineering (MSE), Mechanical Engineering (ME), Marine Technology (MT), Systems and Control (SC) and Offshore Engineering (OE). The faculty also participates in the interfaculty MSc programmes Transport, Infrastructure and Logistics (TIL).
3mE is an abbreviation of Mechanical, Maritime and Materials Engineering. The organisation of the faculty and the structure of the educational and Board of Examiners of the faculty are described in the faculty regulations. The dean has the final responsibility for the faculty. He is assisted by the Director of Education. Together with the department heads they form the management team. The dean is supported by the Faculty staff and is advised by a number of advisory boards.

Dean
Prof. M. Waas
Room: 8F-1-14
Tel: +31 (0)15 27 85401
E-mail: m.waas@tudelft.nl

2.2 EDUCATION AND STUDENT AFFAIRS

The education and student affairs staff is responsible for providing support to Mechanical Engineering students. Students can obtain information on all issues related to the Mechanical Engineering programmes. The department consists of the following staff:

Dr. Eric Logtenberg
Manager Department O&S
Tel: +31 (0)15 27 89520
E-mail: e.h.p.logtenberg@tudelft.nl

Dorothea Brouwer
Assistant Coordinator Education
Tel: +31 (0)15 27 83302
E-mail: d.j.w.m.brouwer@tudelft.nl

Fatma Çinar
Assistant International Coordinator
Tel: +31 (0)15 27 86753
E-mail: f.s.cinar@tudelft.nl

Teuni Eden
Study Adviser
Tel: +31 (0)15 27 82176
E-mail: t.eden@tudelft.nl

Ewoud van Luik
Coordinator Education
Tel: +31 (0)15 27 85734
E-mail: e.p.vanluik@tudelft.nl

Susanne van der Meer
Secretary and Quality Assurance
Tel: +31 (0)15 27 85734
E-mail: s.d.w.m.vandermeer@tudelft.nl

Dr. Dick Nijveldt
Educational Adviser
Tel: +31 (0)15 27 85921
E-mail: d.nijveldt@tudelft.nl

Mascha Toppenberg
International MSc Coordinator
Tel: +31 (0)15 27 86959
E-mail: m.p.i.toppenberg@tudelft.nl

Prof. Dr. Peter Wieringa
Director of Education
Tel: +31 (0)15 27 85763
E-mail: p.a.wieringa@tudelft.nl

Jaap v.d. Zanden
Study Adviser
Tel: +31 (0)15 27 82996
E-mail: j.vanderzanden@tudelft.nl

Education and Student Affairs
Mekelweg 2
2628 CD Delft
Location 8C, ground floor
Tel: +31 (0)15 27 85499
Fax: +31 (0)15 27 88340

2.3 EDUCATION COMMITTEE

The education committee advises the dean and the director of education on the contents and the structure of the study programme and the examinations. The education committee exists of four lecturers and four students. In addition the director of education, the education adviser and a study adviser take part in the meetings.

Chairman
Dr. ir. A.M. Hoogstrate
Tel: +31 (0)15 27 85606
E-mail: a.m.hoogstrate@tudelft.nl

Secretary
Mw. S.D.W.M. van der Meer
Tel: +31 (0)15 27 85499
E-mail: s.d.w.m.vandermeer@tudelft.nl

2.4 BOARD OF EXAMINERS

The Board of Examiners consists of all lecturers involved in the study programme, as mentioned in paragraph 1.5.
The Board of Examiners is responsible for the rules and regulations of the examinations and the assessment of the examination results. Requests for a deviation to the standard programme can be submitted to the Board of Examiners.

Chairman
prof.dr.ir. P.J. Jansens
Tel: +31 (0)15 27 88253
E-mail: p.j.jansens@tudelft.nl

Secretary
E.P. van Luik
Tel: +31 (0)15 27 85734
E-mail: e.p.vanluik@tudelft.nl

2.5 "LEEGHWATER" STUDENTS' SOCIETY

"Gezelschap Leeghwater", the society for students of Mechanical Engineering at the TU Delft, aims to support its members in their studies to represent their interests.

The first of these objectives is fostered by organising excursions and case studies, and by participating in the organisation of the "Delft Company Days". Leeghwater also publishes a yearbook, a diary and, five times a year, the magazine De Slurf.

The second objective, representing students' interests, is reflected in the organisation of "response groups" to provide teaching staff with feedback. Each year, one member of the Leeghwater executive committee is appointed to represent the students in education-related discussions with the faculty and its teaching staff, passing complaints and requests concerning the curriculum, the organisation of the courses and the tutors. This representative can be contacted at onderwijs@leeghwater.nl.

Textbooks, past examination papers and office supplies are sold, at cost price, at the Leeghwater office every weekday, between 10am and 4pm. Leeghwater members can also download and print last year's examination papers on Blackboard.

Gezelschap Leeghwater
Mekelweg 2
2628 CD Delft
Tel: +31 (0)15 27 86501
Fax: +31 (0)15 27 81443
E-mail: info@leeghwater.nl
Website: www.leeghwater.nl

2.6 STUDENT GUIDANCE

For assistance and advice to students the faculty has two study advisers. The study adviser is the person to see about questions or problems related to your studies or issues which may influence your ability to study. The study adviser also acts as a confidential contact to students.

Individual help and advice

The study advisers have no teaching responsibilities and can, therefore, devote themselves to helping individual students solve problems which may be an obstacle to their academic progress. They are also involved in several committees and are in contact with the lecturers, so they are always up-to-date with the latest developments in the Mechanical Engineering programme. They are in contact with the study advisers at the other TU Delft faculties and with those outside the University; they know what is going on in their field.

Personal circumstances

Personal information will often be discussed during a talk with a study adviser. You can be sure that this information will be dealt with confidentially. This kind of information will only be used with your permission for requests to make an exception to TU Delft or faculty regulations.

Advice to the Board of Examiners, a professor, ...

Under certain conditions a study adviser can decide to advise for example the Board of Examiners to change a decision in favour of a specific student. If necessary the study adviser will act as intermediary between student, dean, psychologists and family doctors. The degree to which the study adviser helps a student is up to the student. The study adviser keeps an eye on the academic progress of all students and may contact them if necessary, but you are strongly recommended to contact the study adviser yourself when facing a question or problem. Waiting often only makes the problem worse. You can contact the two study advisers of the faculty with any questions. They also have their own specialisms.

Foreign Student Financial Support (FSFS)

The Delft University of Technology provides financial assistance to foreign students in cases where they face a study delay due to special circumstances like an illness, a physical or sensory disorder, mental problems, and insufficient organisation of the educational programme by the faculty.

Mrs Teunie Eden, study adviser for all 3me BSc and MSc students,
as well as harassment counsellor (see below)
Specialisms: Exchange students, International MSc students,
social programme international students.
Mekelweg 2,
Room 8C, ground floor
E-mail: t.eden@tudelft.nl
Tel: +31 (0)15 27 82176

Jaap v.d. Zanden, study adviser for all 3me BSc and MSc students
Specialisms: Graduate students, polytechnic high school students,
quality control, student mentors.
Mekelweg 2, 8C, ground floor
E-mail: j.vanderzanden@tudelft.nl
Tel: +31 (0)15 27 82996

Dyslexia

Students suffering from dyslexia usually have problems reading and understanding long texts. This may hamper 'normal' academic progress. These students are therefore advised to contact one of the study advisers and to set up a remedial plan. Important issues are:

- A planned study delay often helps
- If necessary, extra time for examinations can be requested
- Studying with a fellow student often improves academic progress
- IBG offers extra student grants

2.7 WORKING CONDITIONS, RSI AND HARASSMENT

RSI (Repetitive Strain Injury) is a well-known problem. Within TU Delft, the number of complaints caused by RSI is increasing. Too many employees and students still neglect the first symptoms of RSI, not knowing where to find answers to their questions. A lot of information on this issue is available on the Internet. An example is www.rsi.pagina.nl. Free software can be downloaded from the 3mE website, which can help you prevent RSI: go to www.3me.tudelft.nl > facilities.

Causes

There are two mechanisms that cause RSI:

- Repetitive tensing of muscles in fingers and hands, without taking breaks, can cause an overload in these muscles. Friction between muscles, tendons and bones can eventually cause damage.
- Constant tension of muscles in the neck, shoulders and arms restricts blood circulation and damages nerves. This results in cold and tingling fingers. Mental stress and poor posture increase this effect.

Symptoms

There are various symptoms that indicate RSI: pain, stiffness, tingling and a loss of strength can occur in the neck shoulders, arms, wrists, hands and sometimes even in the legs. Without rest, these symptoms will only get worse.

Prevention

How to prevent RSI:

- Intersperse repetitive movements, like typing and using a mouse, with non-repetitive ones, like walking to the printer or reading documents.
- Take regular breaks. You are advised to take a 10-minute break after every two hours of work and a 20-second break after every 10 minutes of work in order to improve blood circulation. It is even better to do exercises during these breaks. Anti-RSI software can help in this respect.

- It is strongly discouraged to do more than six hours of computer work a day.
- Make sure that you maintain a good working posture. Arrange the workstation to suit you. Sit straight in front of your monitor and keyboard. The height and distance of the monitor and desk should be sufficient. A chair with a convex back at waist height is favourable.
- Try not to work under stress caused by deadlines or private problems.

Do not ignore the symptoms of RSI. If you have any questions, please contact the following people:

- Study Adviser
- Health & Safety Adviser: Leen Paauw, e-mail l.paauw@tudelft.nl
- Student Health Care (SGZ), tel: +31 (0)15 21 21507, e-mail studentenartsen@sgz.nl
- Student Facility Centre (SFC), e-mail www.sfc.tudelft.nl
- VSSD support, tel: +31 (0)15 27 82057, e-mail www.vssd.nl

Harassment

Harassment is inappropriate, unwanted behaviour that is offensive, frightening, or in any way distressing. Teasing, mocking, gossiping, bullying, sexual or racial intimidation, violence and discrimination are all forms of harassment.

Harassment Counsellor

If you have problems you can turn to the Harassment Counsellor appointed by the Faculty. These counsellors operate on a strictly confidential basis

and can offer advice, information, support and assistance to victims of harassment. When necessary they may enlist the assistance of mediators. They can also assist and guide you should you wish to submit your complaint to the TU Delft Complaints Committee. All actions are subject to your permission and approval. If you experience any problems in this area, do not hesitate! Everyone at TU Delft has the right to feel safe and respected! The Harassment Counsellor of our Faculty is:

Mrs T. Eden
Mekelweg 2
Room 8C, ground floor
Tel: +31 (0)15 27 82176
E-mail: t.eden@tudelft.nl

2.8 QUALITY CONTROL

The quality of the education is continuously monitored and evaluated. This is done by the faculty itself and by external organisations. The results of the evaluations are public. A summary of these results can be found on the Internet. Based on these results, the Education Committee and the Director of Education advise the dean.

Internal Quality Control:

- In order to evaluate the opinion of the students, a course evaluation system is in place. This system gives all students the opportunity of giving their opinion on the education programme. The study programme and courses are evaluated each year by means of a questionnaire.
- Evaluation meetings with students and lecturers.
- Submitting and dealing with complaints. These complaints can be lodged with the student society or the Director of Education.
- The faculty regularly evaluates its education programme and research in self-assessments.

External quality control:

- The programmes are accredited every five years by the NVAO (Nederlands Vlaamse Accreditatie Organisatie). In preparation of the accreditation, the programme is evaluated by a visitation committee formed by QANU (Quality assurance Netherlands Universities)

2.9 INFORMATION SERVICES

Study guide

This study guide is the main source of information on the degree programme and is available to all students from the Service Desk of the Faculty.
The most recent information however is always available on the faculty website. Announcements which are of importance for the study, like changes to the schedules, are posted well in advance on the Faculty homepage and on Blackboard. Schedules of lectures, assignments and examinations are available on the campus site. Any changes to these schedules are given on Blackboard. Grades can also be found on Blackboard.
Information not directly related to the programme, like information from the student society 'Leeghwater', will be published on notice boards. Members of 'Leeghwater' are also kept informed by e-mail.

2.10 FACULTY REGULATIONS

- It is not allowed to smoke within the faculty building.
- Students have to follow the instructions of academic and support staff.
- Upon request of a staff member, students shall identify themselves by showing the campus card.
- Students shall be on time, before the lecture, assignment, instruction or meeting starts. The lecturer or student assistant may refuse admission to students who are late.
- Regular times for lectures to start are:

Lecture	**Start**	**End**
1st hour:	8.45	9.30
2nd hour:	9.45	10.30
3rd hour:	10.45	11.30
4th hour:	11.45	12.30
5th hour:	13.45	14.30
6th hour:	14.45	15.30
7th hour:	15.45	16.30
8th hour:	16.45	17.30

- All bicycles are to be parked in the racks provided.
- Personal belongings can be stored in lockers located in the main hall. In the corridor alongside lecture rooms A – F bigger lockers are available, suitable for storing helmets. All lockers must be emptied at the end of the academic year, before 15 July and the keys should be returned. Lockers still in use after 15 July will be emptied and provided with a new lock at the student's expense.
- Eating and drinking is only allowed in the canteen, the coffee corner and in the immediate surroundings of a drinks or candy machine.
- Writing or drawing on, or intentionally etching into furniture, walls, doors or windows is prohibited.
- General waste and paper should be disposed of in bins.
- The Rules for Use of Computers, Network Connections, Printers and Plotters should be obeyed.
- Violation of rules and regulations can result in suspension or termination of facilities or services. Theft or intentional damage to Tu Delft property and serious misconduct will be brought to the attention of the proper authorities.

Internet facilities

The utilisation of Internet facilities at the faculty is subject to some regulations:
It is allowed to:

- Send e-mails to persons (or applications) from whom it can be expected that they will not consider the e-mail as annoying. Also, you can receive e-mails which can be stored temporarily in the inbox.
- Read online magazines and to place articles in it.
- Use network information services like WWW servers and FTP servers which are currently in use and those that will become available in the future. All use of services is subject to regulations.
- Use the "Intranet DUNeT" on tele Tels provided throughout the faculty.

It is not allowed to:

- Damage or disable facilities.
- Use available facilities in any other way than their intended use: down-loading, uploading and file sharing of copyright-protected items, such as texts, audio and video files in any format is prohibited.
- Download and install any applications on the faculty computers.
- Play computer games using network facilities.
- Make excessive use of the facilities.
- Let a third party use the facilities (including fellow students).
- Do damage to or obstruct other users or equipment linked to the World Wide Web.
- Disrespect other people's privacy, for example by sending information under a false name.
- Become a member of a mailing list outside the faculty without permission of the "dutwmail director". This rule only applies to students.
- Distribute or show material that can be regarded as offensive, for example insulting phrases or pornographic images or movies.

Sanctions:

- The account is deactivated immediately after a violation has occurred.
- In case of serious or repeated violations: prohibition of the use of ICT facilities for up to a year.
- In case of any breach of the law, this will be reported to the police.
- All claims as a result of violations will be passed on to the violator.

3 Facilities

In this study guide, locations in the faculty building are indicated by means of a number and a letter between brackets which can be found on the map on the campus site of 3mE > Facilities. The floor is also indicated (BG= ground floor, 1st = first floor, etc.).

3.1 LECTURE ROOMS / MEETING ROOMS

Lecture rooms are used for lectures, presentations and instruction. The table below summarises all lecture rooms, giving their capacity and location. Meeting rooms are available for meetings, discussions etc. for small groups of students. Reservations can be made at the Education and Student Affairs desk.

Room	Capacity	Location
A	300	6, BG
B	200	6, BG
C	150	6, BG
D	150	6, BG
E	70	6, BG
F	70	6, BG
J	50	8D, 1st
K	30	8G, 1st
L	30	8G, 1st
P	40	4

3.2 INDIVIDUAL STUDY FACILITIES

Individual study places are available at several locations in the faculty. Some of these are equipped with computers. These places are free to use, without a reservation. Places should be left clean and tidy.
In addition to the study places at the Faculty, there are individual study places in the central library. In the library you are expected to observe silence. There, the same rules apply as those for the faculty study places.

3.3 COMPUTER ROOMS

In addition to the computers at the study places, computers are also available in the computer rooms.
All computers provide access to the Internet. The computer rooms are open for use by students, unless they are being used for teaching. In that case, there is restricted access. A schedule on the door of each computer room shows when the room will be in use. The table below gives an overview of all computer rooms and their location.

Room	Location
Athena	building part 4, 1st
Parthemus	building part 4, 1st
Pallas	building part 4, 1st
Design studios	building part 8G, BG

3.4 RESEARCH FACILITIES

The faculty has a number of research laboratories. Students may perform part of their studies in these laboratories, like the MSc thesis or a laboratory exercise. Otherwise, the laboratories are used for research activities of PhD students and staff.

Fluid Mechanics laboratory
Contact Laboratory manager: B v.d. Velden
Tel: +31 (0)15 27 82892
Location: Leeghwaterstraat 21

Delft Bio-robotics Laboratory
Facilities Several bi-pedale robots
Contact Laboratory manager: dr.ir. M. Wisse
Tel: +31 (0)15 27 86585
Location: 5, 1st , room 03-L

Engineering Dynamics Laboratory
Facilities Dynamic test equipment and analyzing systems
Contact
Tel laboratory: +31 (0)15 27 89394
Tel manager: +31 (0)15 27 86739
Location: 5, BG, room 07

Laboratory for Precision Manufacturing and Assembly
Contact ir. J.J.L. Neve
Tel: +31 (0)15 27 86581
Location Leeghwaterstraat 37b

Laboratory for process equipment & Thermal Power Engineering
Facilities Pilot scale research equipment and utilities, Analytical equipment, Computational Tools
Contact Laboratory manager: J. v. Os
Tel: +31 (0)15 27 86921
Location: API building, Leeghwaterstraat 44

Laboratory for Systems and Control
Contact Laboratory manager: ing. R. van Puffelen
Location: 5, BG

Mechanics of Materials Laboratory
Facilities Test machines and analyzing equipment
Contact
Tel: +31 (0)15 27 89394 / 89424
Location: 5, BG, room 07

Tribology Laboratory
Facilities Tribological Test Equipment
Contact Laboratory manager: B. Hoevenaar
Tel: +31 (0)15 27 86805
Location: 5, BG, room 16

3.5 LECTURE NOTES AND BOOKS

Most lecture notes required for courses at the faculty can be bought at the 'repro', as well as some book and office supplies. Books are also available from the student society 'Leeghwater' (www.leeghwater.nl) and VSSD (www.vssd.nl).
Opening hours repro: Monday to Friday, 9:00 - 16:00.
Website: www.io.tudelft.nl/repro/
Tel: +31 (0)15 27 83062
Room: 10, BG (see campus site 3mE > Facilities)

For courses at other faculties, lecture notes can be bought at the faculties concerned:

- Aerospace Engineering
  Location: 1st floor
  Tel: +31 (0)15 27 81250
- Applied Physics
  Room no. C 057
  Tel: +31 (0)15 27 87992
- Civil Engineering
  Tel: +31 (0)15 27 81727
- Management of Technology
  Location: ground floor, next to entrance
  Tel: +31 (0)15 27 86373
- Electrical Engineering, Mathematics and Computer Science (EWI)
  Room 350
  Tel: +31 (0)15 27 87855

3.6 CATERING

The faculty offers a variety of catering facilities.

Canteen
The faculty canteen serves a wide range of lunch choices. The canteen can be found at location 10, BG.

Coffee corner
The coffee corner offers quick snacks. The coffee corner is situated near the main entrance (8F). Chairs, tables and couches are available. Drinks and candy machines are situated opposite the coffee corner. Paying at these machines is only possible with the electronic chip card 'or chipknip'.

Faculty room
The faculty room is the place to hold symposia, meetings or graduation parties ("afstudeerborrels"). A reservation can be made at the Service Desk of the Faculty 3mE.

't Lagerhuysch
't Lagerhuysch is situated below ground level in section 8B, with access from the square in front of the faculty. Graduation parties (afstudeerborrels) can be held in the Lagerhuysch, but also symposia and meetings.
The student societies Gezelschap Leeghwater and William Froude regularly organise activities. A route description to the Lagerhuysch and a reservation form can be found on their website: www.lagerhuysch.tudelft.nl

Aula Congress Centre
The Aula Congress Centre of TU Delft offers a variety of catering facilities. They are open for lunch from 11.30 to 13.30, and for dinner from 16.30 to 19.30.

3.7 MAP OF THE FACULTY
This guide mentions numbers, indicating locations in the faculty building. As an extensive map could not be included in this guide, please visit the 3ME website to view the map: campus.3me.tudelft.nl > Facilities.

4. Course Descriptions

Course descriptions of MSc courses are not part of this guide. Detailed information is available in the Digital Study Guide via the Study Information System (SIS) on www.tudelft.nl/sis

5. Course and Examination Regulations / Regulations and Guidelines for the Board of Examiners

The Course and Examination Regulations and the Regulations and Guidelines for the Board of Examiners are available on campus.3me.tudelft.nl