BioMedical Engineering

MSc Programme

Study Guide
2006/2007

www.masteryourfuture.nl

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.

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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

We are very happy that as from 1 September 2006 the MSc programme in Biomedical Engineering will start its third year. A number of students received their MSc degree BME already and this coming year many students of the first cohort (which started in 2004) will follow. Most of them really did find the study that they were looking for: Challenging, interesting, relevant, multi-disciplinary, application-oriented, etc.

The educational programme has been improved during these first years. Of course, many small annoyances have been corrected, but some fundamental changes also took place. The unique collaboration in an inter-faculty MSc programme between the Departments of Applied Sciences, Electrical Engineering and Mechanical Engineering has some difficulties in adjusting the lecture schedules, examinations, etc. But the good part is that students are encouraged to look beyond the traditional disciplinary walls, and learn to discover new horizons.

The contribution of our clinical partners of the Leiden University Medical Center and the Erasmus Medical Center Rotterdam is very important. Medical doctors come over to the campus of Delft and introduce the BME students to the clinical problems they are facing. Many times, the future BME engineers make the trip to Leiden and Rotterdam to be exposed directly to the clinical environment. During the coming year, many BME students will complete their MSc thesis assignment, or at least part of it, at the Leiden and Rotterdam premises. In order to illustrate the good collaboration, medical students have also been coming to Delft during the past two years, in order to take an introductory course in Biomedical Engineering. Medical doctors with a good appreciation of engineering methodology and design are very important as a counterpart to the BME engineers. This coming year, more medical students are likely to complete part of their study in Delft.

The BME programme at Delft University of Technology is different from the other BME programmes offered in the Netherlands, because it focuses on the education of good engineers within the traditional engineering disciplines, but who can also apply their skills within a multi-disciplinary team of researchers, in which medical scientists will also be represented. During the MSc education there is a focus on multi-disciplinary collaboration, and the MSc thesis will be guided by technical as well as clinical tutors.

There are still many things to discover in the field of Biomedical Engineering and there is a continuous quest for better devices. It is a hi-tech field where university research programmes still can compete (and collaborate!) with industrial programmes. The importance for society is evident. It is very rewarding for students to see that their efforts may affect the clinical practice directly or indirectly.

We are looking forward to the coming year and many new opportunities for students, researchers and clinicians!

Prof. Frans C.T. van der Helm

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 8.00 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.

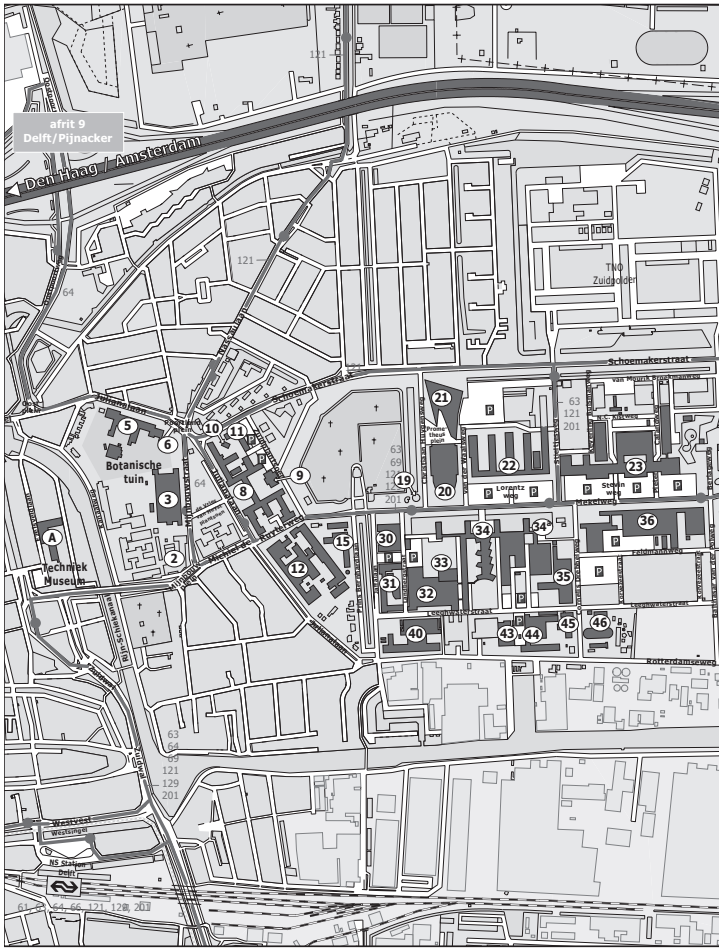
Student Health Care: SGZ
Surinamestraat 4
2612 EA Delft
To make an appointment, call +31 (0)15 212 1507
Monday to Friday 8.30-12.15

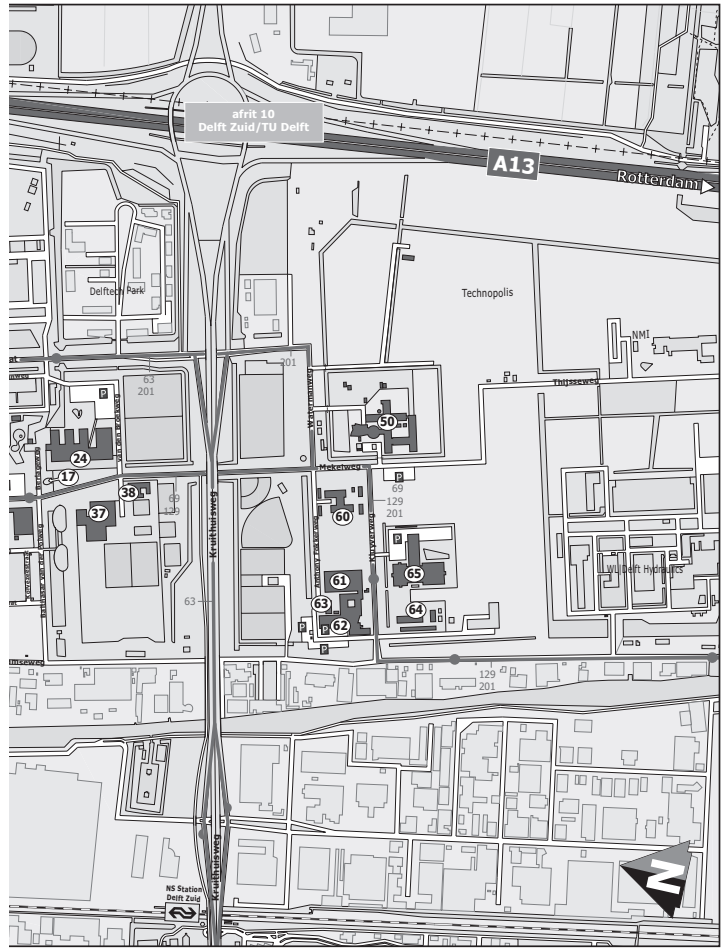
Stichting DUWO
(Delft Housing Agency)
Marlotlaan 5
2614 GV Delft
Tel: +31 (0)15 219 2200
E-mail: info@duwo.nl
Website: www.duwo.nl
Office hours: Monday to Friday 08.30-17.00.

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





= buslijn met halte

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. Introduction

Biomedical Engineering (BME) involves the application of engineering principles and technologies to medicine and biology so as to define and solve problems in these fields.

At Delft University of Technology, a two-year MSc programme in Biomedical Engineering has started in September 2004. Although it is a young programme, it is based on a long history of education and research in BME within three collaborating faculties: Faculty of Applied Sciences, Faculty of Electrical Engineering, Mathematics and Computer Science, and Faculty of Mechanical Engineering, Marine Technology and Materials Science. By bundling the BME knowledge in these faculties, a broad BME programme could be realised. Additionally, there is a close and intensive collaboration with clinical partners at Leiden University Medical Center (LUMC), Erasmus Medical Center Rotterdam (Erasmus MC), and Academic Medical Center Amsterdam (AMC). The clinical partners participate in the teaching process in the first MSc year (LUMC and Erasmus MC), and in the tutoring process of the MSc projects in the second year (LUMC, Erasmus MC, and AMC).

Biomedical engineers have a solid technical background and additional knowledge of the medical field. In the biomedical industry, they apply their knowledge for the development and improvement of instruments for minimal invasive surgery, joint replacement prostheses, pacemakers, catheters etc. Within the health service, especially in academic medical centres, biomedical engineers participate in research and education. Two examples are biomechanical research focused on the improvement of joint replacement prostheses at a department of Orthopaedics, and image-processing research for the automated detection of narrowing blood vessels at a department of Cardiology.

In total, six specialisations are offered within the MSc BME programme. Three of these specialisations require a background in Mechanical Engineering; two require a background in (Applied) Physics, and one in Electrical Engineering. This means that Bachelors of Science with a Mechanical Engineering, Applied Physics or Electrical Engineering degree from a University of Technology can enter the BME programme without any restrictions. TU Delft bachelors with another degree can also enter the programme, however, only after having attended some additional courses. Bachelors with a degree of a Dutch university of professional education (*In Dutch: Technische Hogeschool*) may also enter the programme with a number of additional courses: The Pre-Master's programme. Additional (Bachelor's) courses up to 15 credits may be incorporated in the MSc programme. If more additional courses are required, they are added to the Master's programme. See chapter 6 for detailed information about enrolment.

Chapter 2 defines the goal of the Master's programme Biomedical Engineering and chapter 3 describes the qualifications of the graduated Master of Science Biomedical Engineering. In chapter 4, an overview of the study programme is given. Subsequently, in chapter 5, the admission programmes for academic Bachelor's and Dutch higher professional education Bachelor's are described. Then, the six specialisations are presented in more detail in chapter 6. The medical courses that can be taken at LUMC and Erasmus MC and some of the research groups in the two academic hospitals that offer final Master's thesis assignments are presented in chapter 7. Next, in chapter 8, an overview of biomedical and medical courses is given, and subsequently an overview of mathematics and engineering courses. Studying abroad is strongly stimulated within the TU Delft in general and within BME specifically. More information on this topic is given in chapter 9. Finally, pass rules and criteria for graduation "cum laude" are presented.

2. Objective

The objective of the Master's programme Biomedical Engineering is to educate graduates in Biomedical Engineering who are technically high-skilled and have additional medical and biological knowledge. These graduates are capable of collaborating with physicians, researchers and other healthcare professionals in order:

- To identify, define and analyse biomedical problems to the solution of which Biomedical Engineering principles and techniques can contribute
- To develop and to produce a sound solution to the problem
- To present 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.

3. Study programme

3.1 INTRODUCTION

Biomedical Engineering is an academic Master's programme of two years. Within the programme, six specialisations can be distinguished:

- Medical Instruments and Medical Safety (MIMS);
- BioMechatronics (BM);
- Tissue Biomechanics and Implants (TBI);
- Medical Imaging (MI);
- Clinical Physics (CP);
- Biomedical Instrumentation (BI).

These specialisations cover a broad field within Biomedical Engineering. Each specialisation requires its specific background knowledge.

At the beginning of the study programme each student must choose a specialisation. Switching between specialisations remains possible, but the student should take into account the compulsory courses and possibly the additional required courses for each specialisation.

This chapter provides some general information on teaching periods, examinations, and European Credits. Thereafter, the programme of the first and second study years is presented.

3.2 GENERAL INFORMATION

3.2.1 SEMESTERS AND PERIODS

Each course year is divided into two semesters. Every semester consists of two periods (quarters). In this study guide, these periods will be referred to as 1A, 1B, 2A and 2B. A period consists of seven weeks of lectures, followed by two or three weeks in which examinations can be scheduled.

3.2.2 EXAMINATIONS

Examinations can be oral or written. For those subjects with regard to which written examinations are scheduled, the student will get at least one opportunity per year to sit a re-examination (written or orally). Examinations are scheduled right after the period during which the course is given. Re-examinations generally take place after the next period. Re-examinations for the examinations taken in period 2B are scheduled in the second half of August.

3.2.3 STUDY LOAD AND EUROPEAN CREDITS

The study load of a course is expressed in European Credits (EC). 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 study year is 60 credits. These give an indication of the weight of a certain part of the course. One credit involves approximately 28 hours of study. The study load includes all time spent on the course: lectures, self-education, traineeship, practical assignments, examinations, etc. The study programme involves two years of study, each with a study load of 60 credirts. The total programme is 120 credits.

3.3 THE FIRST MSC YEAR (60 CREDITS)

In the first year, students are expected to take at least 30 credits in biomedical courses, and at least 30 credits in fundamental technical courses. Biomedical courses consist of medical, medical technology, and biophysics courses.

There is a compulsory part – specific for each specialisation – for the biomedical courses as well as the fundamental technical courses, and there is an elective part that has to be chosen in consultation with the professor responsible for the specialisation. For this part, there is a list of recommended courses and other elective courses (see Tables IX, X, and XI).

The medical technology and biophysics courses are given by engineers and clinicians. The clinicians will explain the clinical problems and their viewpoints, as well as the progress in clinically-related research. There are several medical courses that can be taken within the educational

programme of two of our clinical partner universities, Leiden University Medical Center and Erasmus Medical Center Rotterdam: students are allowed to take these medical courses with a maximum of 10 credits.

From the engineering viewpoint, there will be an emphasis on the technical and biophysical aspects, i.e. what is the state of the art in design, modelling and simulation. Here, the relation will be made with the engineering background of the students.

Students are stimulated to complete part of their study, e.g. the traineeship, abroad. For more information look at "Chapter 9: Study and traineeship abroad" of this guide.

3.4 THE SECOND MSC YEAR (60 CREDITS)

The second year will start with a traineeship in a biomedical research group or biomedical company. Bachelors from higher professional education (TH) get dispensation for this traineeship. Thereafter, a literature survey and a Master's thesis project will be carried out. The order of traineeship and literature survey can be switched.

In general, the assignments are carried out individually. The most effective way is to complete the literature survey, traineeship and the Master's thesis project in the same field of research. In order to assure the multi-disciplinary nature of the BME education, the Master's thesis project will be tutored by a technical as well as a clinical staff member.

Important!
Each year at the end of April, two introductory days for Master students are organised: one in Leiden and one in Rotterdam. During these days, information about the research groups and traineeships and Master's thesis assignments will be presented. The exact date will be announced on the Biomedical Engineering community on Blackboard.

3.4.1 TRAINEESHIP IN A HOSPITAL, INDUSTRY OR OTHER RESEARCH INSTITUTE (12 CREDITS)

During the traineeship a project task, defined in consultation with the host institute, should be carried out. For Dutch students, it is recommended to complete the traineeship abroad. The faculty of the Biomedical Engineering Master's programme will support initiatives for that purpose, or will actively help to find host institutes. The traineeship should be finished with a report.

Important!
Bachelors with a higher professional education degree are exempted from the traineeship.

Usually, the traineeship is arranged via one of the staff members of the chosen specialisation. Additionally, the Information Centre of the Student Facility Centre offers 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 on the website: www.sfc.tudelft.nl.

You may also contact the coordinator for International Exchange:

Mrs Mascha Toppenberg
Room 8B-2-31
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

Important!
The student is encouraged to contact the responsible professor of his specialisation at the beginning of the selection process of the traineeship. This avoids problems at a later stage: the professor has a good overview of institutes and companies within his working area and is able to judge if the chosen institute or company will be appropriate. The responsible professor will have to give his approval before the traineeship is started.

3.4.2 LITERATURE SURVEY (10 CREDITS)

It is recommended to carry out the literature survey in the same research field as the Master's thesis project. The literature survey will be finished with a report, and a presentation in a seminar with staff and fellow students.

3.4.3 MASTER'S THESIS PROJECT (38 CREDITS)

The Master's thesis project will be the final part of the BME programme. Preferably, the project will be done in collaboration with a clinical partner from Leiden University Medical Center (LUMC), Erasmus Medical Center (ERASMUS MC) Rotterdam, or Academic Medical Center (AMC) Amsterdam. Each MSc student will have a clinical tutor and a technical tutor, whether the thesis work is done in Delft or at the premises of the clinical partner. About six weeks after the start of the project, the student will give an introductory presentation in which the goals of the project, methodology and the research plan will be outlined. The student prepares the MSc thesis as a report of his/her project. The thesis work is evaluated through an oral presentation (graduation seminar) by the candidate and an oral examination before a MSc examination committee composed of at least three scientific staff members, including the thesis supervisor and one staff member from outside the research group. The examination committee may also include external examiners from research institutes or from industrial partners.

Note

An overview of Master's assignments will be published on the BME site www.bme.tudelft.nl) in due course.

3.4.4 ORAL PRESENTATIONS

In multi-disciplinary research it is essential for students to have good communication skills. Therefore, each student has to give three oral presentations (seminars) so he will be trained to deliver a clear message to people with another background. A grade will be given for each presentation: one for the literature seminar, one for the seminar given six weeks after the start of his Master's assignment (introductory seminar), and one at the end of his Master's thesis project (graduation seminar). The seminars will be organised centrally for all Biomedical Engineering students. It is compulsory for all Biomedical Engineering students to attend these seminars in their final year.

3.5 STUDENT INTERVIEWS

We feel that it is essential for a student to know what is expected from him, and that the student informs us of any problems within the study programme, so we can make improvements.

The beginning of the academic year sees a central presentation where we will give the new students a thorough introduction to the BME programme, and where the new students can meet each other.

Thereafter, before 15 October a personalised education programme will be drawn up in consultation with the study coordinator (Dr. Edward Valstar). This programme will have to be approved by the professor responsible for the chosen specialisation, and by the Examination Board.

In addition, an official student interview is planned for each student on an annual basis. The objective of this interview is to discuss study progress and to receive feedback on the study programme. The student must complete a questionnaire (anonymously) and based on the results of the questionnaires, action can be taken to improve courses.

Important!

The student interviews are an addition to, but not a replacement for, regular student-professor contact, which will be held on a more informal basis.

4. Specialisations within the MSc BME programme

4.1 INTRODUCTION

For students starting the BME Master's programme, it is essential to know that the programme is divided into 6 specialisations.

- Medical Instruments and Safety
- Biomechatronics
- Tissue Biomechanics and Implants
- Medical Imaging
- Clinical Physics
- Biomedical Instrumentation

Not only do these specialisations focus on different aspects of biomedical engineering, they also require different baseline knowledge to be admitted to the specialisation.

Important!
At the beginning of the study programme, each student must choose a specialisation. Switching between specialisations remains possible, but the student should take into account the compulsory courses and possibly the additional required courses for each specialisation.

In this chapter, the focus of education and research of each specialization is described. In the next chapter the specific deficiency programmes for admittance to the specialisations will be discussed.

4.2 SPECIALISATION MEDICAL INSTRUMENTS & MEDICAL SAFETY (MIMS)

Responsible professor: Prof. Dr. Jenny Dankelman
Tel: +31 (0)15 27 85763
E-mail: j.dankelman@tudelft.nl
Prof. Dr. Ir. Peter A. Wieringa, Prof. Dr. Ir. Cees A. Grimbergen

Man-Machine Systems Group, Dept. of Biomechanical Engineering, Faculty of Mechanical, Maritime and Materials Engineering (3ME)

OVERVIEW

The goal of the research within the Medical Instrumentation & Medical Safety specialisation is to develop new devices, processes and systems to improve the quality and safety of the provision of healthcare. Medical instrument development occurs in several medical disciplines, e.g. minimally invasive surgery, colonoscopy, and catheter interventions. To operate through small incisions in the skin, surgeons need special instrumentation which makes the minimally invasive technique a difficult one to apply. Therefore, new flexible instruments are developed to be used for minimally invasive surgery. A new locomotion system is developed in the field of colonoscopy, to move more easily through the bowel and prevent causing pain to the patient. The research related to medical instruments also involves the quality of medical instruments, optimal use, maintenance and sterilisation. To train surgeons outside the operation theatre, new training equipment is developed, such as virtual reality trainers and simulators having force/haptic feedback.

This specialisation is aimed at the medical specialisations of surgery, cardiovascular diseases and gastroenterology.

ADMISSION

Only Bachelors of Science with an academic degree in Mechanical or Biomedical Engineering are admitted to this specialisation without having to take any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in Table I.

4.3 SPECIALISATION BIOMECHATRONICS (BM)

Responsible professor: Prof. Frans C.T. van der Helm
Tel: +31 (0)15 27 85616
E-mail: f.c.t.vanderhelm@tudelft.nl

Biomechatronics & Bio-robotics group, Dept. of Biomechanical Engineering, Faculty of Mechanical, Maritime and Materials Engineering (3ME)

OVERVIEW

Biomechatronics is the interdisciplinary study of biology, mechanics, and electronics. It focuses on the research and design of assistive and diagnostic devices for patients with disorders of the neuro-musculo-skeletal system. A thorough knowledge of the health system is required, in addition to knowledge of the status of the patients, i.e. the disease causes and symptoms. In particular, biophysical models of muscles, joints, Central Nervous System and sensors, and human motion control are very helpful for analysis and innovative designs.

The interactivity of biological organs (including the brain) with electro-mechanical devices and systems is an important item. In this specialisation, the main focus will be on prosthetics, orthotics, joint implants, diagnostic devices for neurological disorders, neuro-rehabilitation robots, haptic interfaces, etc. Examples of more electronic devices have been around for some time, e.g. the heart pacemaker and cochlear implants (a hearing aid for deaf persons). Other exciting biomechatronic possibilities that scientists foresee in the near future include electronic stimulators of muscles and nerves for patients suffering from strokes and patients suffering from trauma of the central nervous system.

ADMISSION

Only Bachelors of Science with an academic degree in Mechanical or Biomedical Engineering are admitted to this specialisation without having to take any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in Table I.

4.4 TISSUE BIOMECHANICS AND IMPLANTS (TBI)

Responsible professor: Prof. Fred van Keulen
Tel: +31 (0)15 27 86515
E-mail: f.vankeulen@tudelft.nl

Dr. Jacqueline van der Linden
E-mail: j.c.vanderlinden@tudelft.nl

Structural Optimisation & Computational Mechanics, Faculty of Mechanical, Maritime and Materials Engineering (3ME)

OVERVIEW

Despite the long experience in joint replacement prostheses (the first were implanted in the 1960s), these prostheses are not perfect yet. Very good results have been achieved using hip prostheses, but prostheses for e.g. the shoulder joint and fingers frequently fail. To improve these prostheses, close cooperation between the medical and technical profession is essential.

In this Master's programme, you will gain knowledge about skeletal tissues (bone, cartilage, and tendons), anatomy of the joints, and methods to measure and calculate stresses and strains in the bone as well as in the prosthesis and materials that can be used in the human body, which have to be both biocompatible and durable. The biomechanical properties of the tissues in the skeleton will be explored: what is the strength and stiffness of these materials, and - maybe even more important - how do these tissues change during the aging process and in the event of diseases, how does the tissue react when a prosthesis is inserted?

Bone is living tissue that can adapt its mass and architecture to changes in external loads: astronauts lose bone, tennis players have a larger bone mass in their dominant arm. Via the same adaptation mechanism, changes in the loading of the bone caused by implantation of a prosthesis will induce changes in bone mass. When developing prostheses, we have to try to predict these changes and take advantage of the adaptive capability of the skeleton. In order to do this, mechanical tests and advanced computer models need to be combined.

At the end of this specialisation, you will be able to combine technical and biomedical knowledge in order to make a valuable contribution to new developments in the field of orthopaedics.

ADMISSION

Only Bachelors of Science with an academic degree in Mechanical Engineering are admitted to this specialisation without having to attend any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in Table II.

4.5 MEDICAL IMAGING (MI)

Responsible professor: Prof. Albert Vossepoel
Tel: +31 (0)15 27 82033
E-mail: A.M.Vossepoel@tudelft.nl

Quantitative Imaging Group, Faculty of Applied Sciences

OVERVIEW

In modern medicine, imaging plays an increasingly important role. Nowadays imaging modalities, such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and diagnostic ultrasound provide high-quality three-dimensional or even four-dimensional pictures: not only of the human anatomy, but also of its function and the changes over time, aspects that are truly characteristic of the medical field. The high quality of these pictures must be balanced against human factors such as acquisition time and radiation burden for the patient.

The task of the MSc in this specialisation is to provide user interface and visualisation facilities for the many Terabytes of data that are produced yearly in a hospital. It is even more important to provide quantitative, accurate and consistent measurements of the objects of interest in the images, in order to complement the qualitative judgement of the radiologist or other medical specialist. When the images have been acquired through different imaging methods, or at different moments, it is necessary to match or register the individual images, before they can be fused or subtracted from each other.

Intelligent utilisation of the measurements can lead to interpretation and classification of the image content, which in turn can provide important diagnostic decision support.

Like every MSc in Biomedical Engineering, an MSc in this specialisation must show competence in cooperating with medical specialists, giving frequent feedback on the problem at hand as well as on the proposed solutions.

Professional opportunities can be found in medical research, clinical support, and with suppliers and manufacturers of the various devices for acquisition and processing of medical images, mainly aimed at radiology.

ADMISSION

Only Bachelors of Science with an academic degree in Applied Physics are admitted to this specialisation without having to attend any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in Table III.

4.6 CLINICAL PHYSICS (CP)

Responsible professor: Prof. C.E. van Eijk
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E-mail: C.W.E.vanEijk@TUDelft.nl

Dr. J. Zoetelief

Interfaculty Reactor Institute (IRI), Faculty of Applied Sciences

OVERVIEW

Clinical physics is a specialisation that has been developing strongly in recent years. On the one hand this is due to the ever-increasing application of physical methods in healthcare. On the other it appears that clinical physicists are valuable partners in discussions among the various professionals working at healthcare institutions.

Clinical physicists are responsible for the standardisation and calibration of the medical instrumentation in close cooperation with medical and paramedical professionals. Furthermore, they are responsible for the accuracy and safety of physical methods, applied in the hospital for diagnosis and

therapy. The clinical physicist often has a strong position with respect to investments in medical equipment. Medical professionals and hospital management heavily rely on his or her judgement. Topics can be divided into five areas of interest: general medical physics, radiation therapy, radiology, nuclear medicine and audiology. In radiotherapy, clinical physicists play a major role in treatment planning. Often, clinical physicists are involved in research projects.

The Biomedical MSc programme specialisation Clinical Physics will be preparatory to the post-doctoral education on clinical physics. In the first year, the MSc programme consists of about 50 % medical technology and related classes and about 50 % of fundamental technical classes. During the classes on medical physics and radiation technology dealing with medical imaging and radiotherapy, the medical aspects are presented by professionals working in hospitals. In the second year of the MSc programme, there will be an MSc thesis project. Generally, this is carried out at a hospital and tutored by a staff member of Delft University of Technology and a staff member from the hospital.

BME-students who, after completion of the BSc Technische Natuurkunde major (another BSc at a (Technical) University followed by additional Bachelor's courses, or higher professional education bachelors with a degree in Applied Physics can enrol after they have followed a pre-Master's programme of courses that will give them the same level of knowledge as an academic Bachelor in Applied Physics. The additional Bachelor's courses and the pre-Master's programme are exactly the same as those required to enter the Master's programme for Applied Physics) graduated in the MSc BME Clinical Physics can - if they wish - be unconditionally admitted to the selection procedure for the post-initial education "Klinische Fysica".

ADMISSION

Only Bachelors of Science with an academic degree in Applied Physics are admitted to this specialisation without having to attend any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in Table III.

4.7 BIOMEDICAL INSTRUMENTATION (BI)

Responsible professor: Prof. Paddy French
Tel: +31 (0)15 27 84729
E-mail: P.J.French@TUDelft.NL

Electronic Instrumentation Laboratory, Faculty of Electrical Engineering, Mathematics and Computer Science

OVERVIEW

Within the department of Microelectronics, biomedical research activities are aimed at sensor Microsystems in the Laboratory for Electronic Instrumentation and low-voltage, low-power electronics in the Laboratory for Electronics.

The mission of the laboratory for Electronic Instrumentation is to develop smart Microsystems for both analysis and biomedical measurements (both in-vivo and in-vitro). These projects bring together the sensing devices and read-out electronics. In recent years the laboratory has been developing: a catheter navigation system, multi-sensors for catheters (including measurements in blood), microsystems for monitoring cardiac output, blood impedance measurement system, polymerised chain reaction (PCR) chips, streaming potential in bone, blood analysis and drain fluid analysis. These projects have been performed in collaboration with a number of hospitals, biochemical and medical companies.

In this specialisation, design methodologies and proof-of-concept vehicles for low-power adaptive integrated circuits for biomedical wearable, implantable and injectable devices are being developed. These are battery-powered or battery-free biomedical electronic devices, such as hearing instruments, cochlear implants, neuro-stimulators, pacemakers, and wireless links for biomedical sensors used in health monitoring or telemedicine applications. Major design constraints that are taken into account are reliability, low-voltage (0.7 - 3 Volt) and ultra low-power (<< 1mW) operation.

ADMISSION

Only Bachelors of Science with an academic degree in Electrical Engineering are admitted to this specialisation without having to attend any additional courses. Bachelors with another degree need to attend additional courses. More information can be found in section 6.2.5.

5. Admission

5.1 INTRODUCTION

The contents of the Bachelor's degree and study results of each candidate will be evaluated. The intake coordinator of the Examination Committee is responsible for this selection. The admission procedure can result in:

- **Admission without additional requirements.**
- **Admission with additional requirements of no more than 15 credits.** The additional requirements in Bachelor's courses can be part of the elective courses of the chosen specialisation in the Master's programme.
- **Admission with additional requirements between 15 and 45 credits.** In this case 15 credits are part of the 120 credits of the normal MSc programme and no more than 30 credits are required on top of the standard MSc programme.
- **No admission (additional requirements exceed 45 credits).** The candidate has to obtain a relevant Bachelor's degree first.

5.2 ADMISSION FOR STUDENTS WITH AN ACADEMIC BACHELOR'S DEGREE

5.2.1 INTRODUCTION

Students holding an academic Bachelor's degree in Physics from a Dutch university, or a Bachelor's degree in Biomedical Engineering, Applied Physics, Mechanical Engineering, or Electrical Engineering from a Dutch University of Technology (Delft, Eindhoven or Twente) or a University which belongs to the IDEA-league (ETH Zürich, Imperial College London or Technische Universität Aachen) can enter the MSc programme without additional requirements.

However, it is important to note that although there are no formal additional requirements, it might be necessary to take some Bachelor's courses to be admitted to a specific specialisation. Depending on the specialisation, these courses are in the Mechanical Engineering field, in the Applied Physics field or in the Electrical Engineering field.

5.2.2 ADDITIONAL BACHELOR'S COURSES FOR ADMISSION TO MEDICAL INSTRUMENTS AND MEDICAL SAFETY (MIMS) AND BIOMECHATRONICS (BM)

Table I: Overview of additional Bachelor's courses that need to be taken in order to be admitted to the specialisations Medical instruments and Medical Safety (MIMS) and Biomechatronics (BM). The numbers indicated the credits[1].

Course Code	Course Name	BE	AP	ME	EE	AE	MT	ID	CE
wb1216	Dynamics 2	3	3		3		3	3	3
wbtp211	Mechatronics	10	10		10		10		10
sc4020	Control Theory	6	6						
wb2104	Introduction Modelling and Control Eng.								3
wb2207	Control Engineering					3	3	3	3
wi2051wb	Differential equations							3	
wi2252wb	Analysis 3							3	
	Total credits	**19**	**19**	**0**	**13**	**3**	**16**	**12**	**19**

[1] BE = Biomedical Engineering; AP = Bachelor in Applied Physics; ME = Bachelor in Mechanical Engineering; EE = Bachelor in Electrical Engineering; AE = Bachelor in Electrical Engineering; MT = Bachelor in Marine Technology; ID = Bachelor in Industrial Design Engineering; CE = Bachelor in Civil Engineering.

Important!

These specialisations are not recommended for students with a Bachelor in Mathematics or a Bachelor in Computer Science, since the additional Bachelor's courses would cover more than 45 credits.

5.2.3 ADDITIONAL BACHELOR'S COURSES FOR ADMISSION TO TISSUE BIOMECHANICS AND IMPLANTS (TBI)

Table II: Overview of additional Bachelor's courses that need to be taken in order to be admitted to the specialisations Tissue Biomechanics and Implants (TBI). The numbers indicate the credits[1].

Course Code	Course Name	BE	AP	ME	EE	AE	MT	ID	CE
wb1216	Dynamics 2	3	3		3			3	3
wb1311	Mechanics 3	4	4		4		4	4	
wb1217	Strength of Materials 2	3	3		3			3	
wb1218	Non Linear Mechanics	2	2		2			2	
sc4020	Control Theory		6						
wb2104	Introduction Modelling and Control Eng.								3
wb2207	Control Engineering	3				3	3	3	3
wi2051wb	Differential Equations	3						3	
wi2252wb	Analysis 3	3						3	
	Total credits	**21**	**18**	**0**	**12**	**3**	**7**	**21**	**9**

[1] BE = Biomedical Engineering; AP = Bachelor in Applied Physics; ME = Bachelor in Mechanical Engineering; EE = Bachelor in Electrical Engineering; AE = Bachelor in Electrical Engineering; MT = Bachelor in Marine Technology; ID = Bachelor in Industrial Design Engineering; CE = Bachelor in Civil Engineering.

Important!

These specialisations are not recommended for students with a Bachelor in Mathematics or a Bachelor in Computer Science, since the additional Bachelor's courses would cover more than 45 credits.

5.2.4 ADDITIONAL BACHELOR'S COURSES FOR ADMISSION TO MEDICAL IMAGING (MI) AND CLINICAL PHYSICS (CP)

Table III: Overview of additional Bachelor's courses that need to be finished in order to be admitted to the specialisations Medical Imaging (MI) and Clinical Physics (CP). The numbers indicated the credits1.

Course Code	Course Name	BE	AP	ME	EE	AE	MT	MC	CE
tn2512	Computer Science	4		4	4	4	4	4	4
tn2545	Systems and signals	6		6		6	6	6	6
tn2344	Golven	6		6	6	6	6	6	6
tn2344	EM1	5		5		5	5	5	5
tn1662	Natuurkunde 2	3						3	3
	Total credits	**24**	**0**	**21**	**10**	**21**	**21**	**24**	**24**

[1] BE = Biomedical Engineering; AP = Bachelor in Applied Physics; ME = Bachelor in Mechanical Engineering; EE = Bachelor in Electrical Engineering; AE = Bachelor in Electrical Engineering; MT = Bachelor in Marine Technology; MC = Bachelor in Mathematics in Computer Sciences; CE = Bachelor in Civil Engineering.

Important!

These specialisations are not recommended for students with a Bachelor in Industrial Design Engineering.

5.2.5 ADDITIONAL BACHELOR'S COURSES FOR ADMISSION TO BIOMEDICAL INSTRUMENTS (BI)

This specialisation is recommended for students with a Bachelor in Electrical Engineering, who can be admitted directly. Students with degrees such as Applied Physics must demonstrate that they have at least 13 credits in Electrical Engineering courses in their Bachelor curriculum. Students who do not meet the admission requirements in terms of courses followed, may be required to attend additional courses. This can be arranged on an individual basis.

5.3 ADMISSION FOR STUDENTS WITH A BACHELOR FROM A DUTCH UNIVERSITY OF PROFESSIONAL EDUCATION (TH)

5.3.1 INTRODUCTION

Candidates having a Bachelor's degree from a Dutch TH programme in Electrical Engineering, Mechanical Engineering, Applied Mathematics, Applied Physics, Aerospace Engineering or Human Motion Technology (Bewegingstechnologie) can be admitted. A requirement is that the candidate has completed the TH Bachelor's programme within 4 years, with good results. The intake coordinator of the Examination Committee is responsible for the selection of candidates. There is a special enrolment programme for these students.

An additional pre-Master's programme of approximately 30 credits must be completed before the candidate is formally admitted to the MSc programme. In the pre-Master's programme, a number of courses of the second year of the academic Bachelor's programme must be followed. These additional requirements will ensure that the student has at least an entrance level comparable to the second course year of the academic Bachelor's programme that forms the basis for the relevant specialisation, i.e. Mechanical Engineering for MIMS, BM, and TBI; Applied Physics for MI and CP, and Electrical Engineering for BI. The head of the chosen specialisation may require that a number of third-year courses of the Bachelor's programme are also followed.

Important!

All courses of the pre-Master's programme are in Dutch.

Candidates are formally admitted only to the pre-Master's programme. However, both the pre-Master's programme and MSc courses can be followed in the first MSc year. Formal admission to the MSc programme is given after completing the pre-MSc programme. The proposed pre-Master's programme has to be approved by the Examination Committee.

Important!

As explained above, it is important to note that the pre-Master's

programme gives admission to specific specialisations within the BME MSc programme. That means that a student needs to make a choice for the specialization directly at the start of his BME study.

The total number credits for courses in the MSc programme – including the pre-Master's programme - for Bachelor students from higher professional education is approx. 80 to 90 credits. This is 20 to 30 credits more than for academic Bachelors who do not have a pre-Master's programme. The period during which courses must be attended is about one-and-a-half year.

Important!
Higher professional education bachelors need to plan their courses well in advance. Unfortunately, experience has taught us that it is almost impossible to avoid clashes between Bachelor's courses in the pre-Master's programme and MSc courses. Therefore, we recommend that higher professional education students contact the coordinator of the BME MSc programme - Dr. Ir. Edward Valstar - in their first or second week after they have started their studies at the TU Delft. He can be reached on: e.r.valstar@.tudelft.nl.

5.3.2 PRE-MASTER'S PROGRAMME FOR MEDICAL INSTRUMENTS AND MEDICAL SAFETY (MIMS); BIOMECHATRONICS (BM); AND TISSUE BIOMECHANICS AND IMPLANTS (TBI)

In these three specialisations, Bachelors with a TH degree in Mechanical Engineering, Aerospace Engineering or Human Motion Technology (Bewegingstechnologie) can enrol after they have followed a pre-Master's programme of courses that will give them the same level of knowledge as an academic Bachelor in Mechanical Engineering. Therefore, this pre-Master's programme is almost the same as the pre-Master's programme for the MSc in Mechanical Engineering.

This programme adds an additional 26 credits. However, because these students do not have to complete a traineeship during the MSc phase, the total additional study load compared to academic Bachelors is 16 credits.

Advice on this pre-Master's programme can be obtained from one of the study advisers at the Faculty of Mechanical Engineering, Ir. Jaap van der Zanden. He can be reached on: j.p.p.m.vanderzanden@tudelft.nl.

More detailed information can be found in the MSc study guide of Mechanical Engineering.

Table IV: Pre-Master's programme Mechanical Engineering.

Code	Course name	EC
wi1152th	Analyse 1 TH	3
wi1153th	Analyse 2 TH	3
wi1154th	Analyse 3 TH	3
wi2256th d1	Lineaire algebra 1 TH	3
wi2256th d2	Lineaire algebra 2 TH	3
wb1217 1)	Sterkteleer 2	3
wb1218 1)	Niet lineaire mechanica	2
wb1216 1)	Dynamica 2	3
wb2207 1)	Regeltechniek	3
	Total	**26**

Note: It might be useful for some students to prepare themselves better for some of the second year Bachelor's courses by carefully inspecting the material of the corresponding first-year courses: wb1115 Sterkteleer 1, wb1116 Dynamica A, and wb2104 Introductie Modelvorming en Regeltechniek 1.

5.3.3 PRE-MASTER'S PROGRAMME FOR MEDICAL IMAGING (MI) AND CLINICAL PHYSICS (CP)

In these two specialisations, Bachelors with a TH degree in Applied Physics can enrol after they have followed a pre-Master's programme of courses that will give them the same level of knowledge as an academic Bachelor in Applied Physics. Therefore, this pre-Master's programme is exactly the same as the pre-Master's programme for Applied Physics.

This programme adds an additional 36 credits. However, because these students do not need to complete a traineeship during the MSc phase, the total additional study load compared to academic Bachelor students is 24 credits.

Advice on this pre-Master's programme can be obtained from the higher professional education adviser at the Faculty of Applied Sciences, Mrs Maricha Reedijk. She can be reached on: m.reedijk@tudelft.nl.

More detailed information can be found in the student handbook for the Master of Applied Physics.

Table V: Pre-Master's programme Applied Physics

Code	Course name	EC
tn2545	Systems and signals	6
tn2344	Waves and laboratory exercises	8
tn2012	Quantum mechanics	5
tn2052	Electromagnetism	5
wi2140	Differential equations	6
wi2142	Linear algebra	6
	Total	**36**

5.3.4 PRE-MASTER'S PROGRAMME FOR BIOMEDICAL INSTRUMENTS (BI)

In this specialisation, students with a higher professional education Bachelor in Electrical Engineering can enrol after they have followed a pre-Master's programme of courses that will give them the same level of knowledge as an academic Bachelor in Electrical Engineering. Therefore, this pre-Master's programme is exactly the same as the pre-Master's programme for Electrical Engineering. Part of the pre-Master's programme is carried out on a personal basis. Therefore, it is essential to make an appoint-ment with Prof. Paddy French at the start of the year P.J.French@TUDelft.NL.
He can also provide you with any information that is missing in Table VI.

This programme adds an additional 30 credits. However, because these students do not need to complete a traineeship during the MSc phase, the total additional study load compared to academic Bachelor students is 18 credits. More detailed information can be found in the MSc study guide of Electrical Engineering and on bmt.its.tudelft.nl.

Table VI: Pre-Master's programme Electrical Engineering

Code	Course name	EC
wi1152th	Analyse 1 TH	3
wi1153th	Analyse 2 TH	3
wi1154th	Analyse 3 TH	3
wi2256th d1	Lineaire algebra 1 TH	3
wi2256th d2	Lineaire algebra 2 TH	3
	Discrete structuren	
	Complexe functietheorie	
	A number of electrical engineering courses depend on the exact Bachelor's programme that has been selected	
Recommended		
	Upper-intermediate English	
	OR	
	Written English for Technologists	
	Together with a total of	**30**

5.4 ADMISSION FOR STUDENTS WHO ARE STILL IN THEIR ACADEMIC BACHELOR'S PROGRAMME

A student who has not finished the Bachelor's programme is permitted to sit examinations in the MSc programme, if the examination committee approves. When the student has passed the propaedeutic examination and has a second and third-year study result of at least 100 credits, including the Bachelor's thesis, the student can be conditionally admitted to the MSc programme, to take part in examinations of a number of MSc courses. Final admittance is granted after completing the Bachelor's programme.

6. Education in Leiden (LUMC) and Rotterdam (Erasmus MC)

6.1 INTRODUCTION

Part of the Master's programme can be taken at Leiden University Medical Center, Erasmus Medical Center (Rotterdam). On the one hand there are many possibilities for completing an internship or your Master's thesis assignment in one of these two medical centres, while on the other it is also possible to follow a number of biomedical courses. In Leiden, the focus is on courses for the first Master's year (these courses are mainly given in Dutch, so they can not be attended by non-Dutch speaking students). In Rotterdam the focus is on courses in the second Master's year, although the courses can be taken separately in the first Master's year, they are also integrated in a traineeship programme that is offered.

Important!
Students are allowed to choose these medical courses at LUMC and Erasmus MC with a total of no more than 10 credits. Any additional credits will be added to the total of 120 credits needed to accomplish the MSc BME programme.

This chapter discusses education at LUMC and Erasmus MC, ranging from courses to traineeships to Master's assignments.

6.2 EDUCATION IN LEIDEN

6.2.1 COURSES

Leiden University Medical Center offers several courses to Biomedical Engineering students. These 3 to 4-week courses will be followed together with (bio)medical students to stimulate an interaction between future colleagues.

Important!
The schedule of courses taught at LUMC is optimised for Leiden students. Therefore, these courses can and will overlap the Delft courses and sometimes even the Delft examination period. Please be sure to check carefully if attending a full-time course in Leiden will not interfere too much with the rest of your study programme.

At LUMC, education is based on "doelstellingengestuurd" (objective-oriented) learning. The courses offer lectures (overview, patient demonstration, or response), workgroups, and practicals. The self-study is guided by a module book including self-study assignments. In the workgroups, the material is discussed in more detail under the guidance of a tutor. Each course is concluded with a 3-hour written examination.

Detailed information on the courses and their time schedules can be found on www.lumc.nl/onderwijs.html. You can register for these courses by sending an e-mail to Edward Valstar, coordinator of the BME Master's programme e.r.valstar@tudelft.nl. Registration has to take place at least 1 month in advance, however, it will be highly appreciated if students would make their choice right at the beginning of the academic year. Each course has its own module on Blackboard which the course coordinator uses to communicate with the students. Therefore, students who have been granted admission to the courses will be granted access to the LUMC Blackboard environment.

For course descriptions see the Digital Study Guide on www.tudelft.nl/sis chapter Elective Courses Leiden / Rotterdam

6.2.2 TRAINEESHIPS AND MASTER'S THESIS ASSIGNMENTS

CROSS TABLE

As indicated in Chapter 5, there is an intensive collaboration between the six BME specialisations and several groups in Leiden. In order to provide you with a compact overview of which Leiden groups might provide interesting traineeships or final Master's assignments for the BME specialisation that you have chosen, we first present a cross table here (Table VII).

Table VII: Cross table indicating collaboration between LUMC research groups and the six Biomedical Engineering specialisations in Delft[1]

	MIMS	BM	TBI	MI	CP	BMI
Image Proc. Lab.				X	X	
Orthopaedics	X	X	X	X		
Rehab. Med.		X				
Ear, Nose Throat			X	X		X
Neurology		X				
Gynaecology	X			X		
Pathology		X		X		

[1] MIMS = Medical Instruments and Medical Safety; BM = BioMechatronics; TBI = Tissue Biomechanics and Implants; MI = Medical Imaging; CP = Clinical Physics; BMI = BioMedical Instruments

DESCRIPTION OF RESEARCH GROUPS

Division of Image Processing (LKEB), Department of Radiology

Prof. Dr. Hans (J.H.C) Reiber; Dr. Berend C. Stoel;
Dr. Ir. Boudewijn L.F. Lelieveldt
Contact: b.c.stoel@lumc.nl
Website: www.lumc.nl/lkeb
Graduation projects:

www.lumc.nl/1010/LKEBHome/english/onderwijs/LKEBonderwijs_english.html

The Division of Image Processing (LKEB) is a division of the Department of Radiology at the Leiden University Medical Center.

Generally, research is aimed at image analysis techniques, which facilitate the interpretation of biomedical images, and specifically at the development of algorithms that can perform objective quantitative measurements in daily clinical practice.

LKEB is divided into six sections, four of which are dedicated to segmentation, quantification and visualisation for specific applications: Intravascular Ultrasound, Cardiovascular Magnetic Resonance Imaging, Orthopaedics & Pulmonology and Neuro-image Processing. In two sections, research is performed mostly independently of modality and application: the X-ray Vascular Imaging & Quality Assurance section (large-scale clinical validation) and the Knowledge Guided Image Processing section (fundamental image processing, integrating shape and feature knowledge).

Biomechanics and Imaging Group, Department of Orthopaedics

Prof. Dr. Piet M. Rozing; Dr. Ir. Edward R. Valstar;
Dr. Rob G.H.H. Nelissen
Contact: e.r.valstar@lumc.nl
Website: www.lumc.nl/orthopaedics
The research of this group focuses on four lines:

1. Functional analysis and biomechanical modelling of the pathologic and prosthetic joint. At the Motion Analysis Laboratory of the LUMC, external motion registration equipment is available for three-dimensional recording of shoulder movements. In addition, EMG and forces can be recorded. This data can be used to predict and to evaluate the effects of surgical treatments.

2 Improvement of treatment of the pathological joint as a result of the development of new endoprostheses (shoulder, elbow, wrist, hand).

3. Improving surgical techniques (minimal invasive surgery, computer-assisted surgery)

4. Development of accurate assessment tools for endoprothesis migration (roentgen stereophotogrammetry (RSA), fluoroscopy).

Interesting traineeships and Master's thesis projects are available for each line of research. Please contact either Edward Valstar or the responsible professor of your specialisation for more information.

Department of Rehabilitation Medicine
Prof. Dr. Hans (J.H.) Arendzen; Dr. Ir. Jurriaan H. de Groot;
Dr. Carel G.M. Meskers.
Contact: j.h.de_groot@lumc.nl
Website: in progress

Graduation projects: contact Jurriaan de Groot.

Experimental research focuses on the description, analysis and prediction of hand and arm functions. The department of rehabilitation medicine is involved in four project themes:

1. Neuromuscular changes following a stroke (cerebrovascular accident, CVA). Spastic paresis involves velocity and position-dependent joint stiffness changes that originate from reduced muscle activation (paresis), changes in spinal reflex gains and muscular properties. In cooperation with the department of neurology (LUMC) and the department of Biomechanical Engineering (Delft) the neuromuscular reflex system is identified through force and position perturbation of the wrist joint.

2. Velocity-dependent joint stiffness of spastic paresis may be related to a decrease of muscle work. Energy dissipation of healthy and spastic muscles in vivo is monitored by means of 31P-NMR (nuclear magnetic resonance) in cooperation with the department of radiology (LUMC).

3. Hand function in daily activities is determined by the kinematics and torques of three shoulder joints, the elbow joint and the wrist joints. The range of motion, possible compensation mechanisms and joint hierarchy of the degrees of freedom in the upper extremity are studied for intervention planning, intervention follow-up and patient information.

4. Muscle forces in the shoulder can only be determined by inverse model simulation. We developed an experimental method for relative muscle activation analysis applying a rotating external force on the arm. In cooperation with the department of Orthopaedic surgery this method is applied to the analysis of glenohumeral pathology e.g. rotator cuff injury, endoprothesis.

Department of Ear, Nose and Throat Surgery
Prof. Dr. Ir. Johan H.M. Frijns, Ir. J.J. Briaire, Dr. Ir. W. Soede
Contact: j.h.m.frijns@lumc.nl
Website: www.lumc.nl/kno/algemeen/subspecialismen.html#1

Cochlear implants are neuro-prosthetic devices that are widely used to rehabilitate deaf patients. Modern multi-channel devices enable most recipients to gain open set speech understanding (using the telephone).

In Leiden the research on cochlear implants predominantly focuses on the relationship between the electrode array in the cochlea and the auditory nerve fibres that are to be stimulated. This includes developing and understanding new electrode designs, speech coding strategies and tools to automate the selection of the parameters on an individual basis. The group uniquely combines computational modelling with electrophysiological experiments in animals and psychophysical and electrophysiological research in implanted patients.

Since 1995 the Leiden computer model, which combines a detailed 3D model of the implanted cochlea with an active neural model, has been widely recognised as leading in the field. It has been applied in the development of several electrodes in collaboration with Philips and Advanced Bionics (Sylmar, CA, USA). The latest development, based on the model insights and clinical research, is the HiFocus4L electrode, which will be produced by Advanced Bionics, and coupled to their newest electronics. To keep up with ever increasing demands for computational power for the computer model, a 9-PC computer cluster with RAID storage and a Gigabit backbone was realised in 2003. This enables the further development of (stochastic) multi-axial neural models and more elaborate modelling of the electrical volume conduction model. The insights will have a continuous direct impact on the clinical CI programme in the LUMC. Collaborations include the department of Neuroradiology (LUMC), the University of Antwerp,

the University of California at San Francisco, the University of Rostock and the University of Washington. The latter collaboration focuses on the improvement of temporal coding at the level of the auditory nerve (and, consequently, of speech intelligibility in noise and music perception) by adding sub-threshold high-frequency (so-called conditioning) signals to conventional speech processing schemes.

Department of Neurology
Dr. J.J. van Hilten
Contact: J.J.van_Hilten@lumc.nl

At the department of Neurology there is a long-lasting history of research among patients with neurological disorders who also show motor dysfunctions, like patients with Parkinson's disease, CVA and Complex Regional Pain Syndrome. A clinical diagnosis of these patients is made using questionnaires and simple manual tests. There is an increasing desire for more objective tests for diagnosis, assessing the disease progress and the effects of medication. In collaboration with the department of neurophysiology, rehabilitation medicine and Delft University of Technology a number of these tests are being developed or improved. For patients with symptoms of bradykinesia (dysfunction of fine motor coordination) for instance, a test is being developed to quantify the ability of fast finger and thumb motions. For patients with Parkinson's disease and CRPS, tests are being developed to measure the reflex gains. Other advanced measurement methods, e.g. functional MRI, EEG, SSEP, are also being investigated.

Section Endoscopy, Department of Gynaecology
Dr. F.W. Jansen
Contact: f.w.jansen@lumc.nl
Website: www.lumc.nl/3040/patientenzorg/endoscopie.html

The research of this group focuses on:

1. Training of surgeons. Development of measurement tools for the objective assessment of surgical skills. At this moment training in the skills lab is not compulsory for two reasons. First, it is unknown what the required skills are and second, current performance measurements are subjective. Box trainers and virtual reality trainers are available for training outside the OR. Box trainers are hardly used because they are not challenging to use and an objective performance assessment is not possible. Objective assessment is currently possible in virtual reality simulators. However, these simulators are very costly and most of them do not incorporate haptic feedback. The challenge is to combine the benefits of both the standard box trainers and virtual reality trainers. To achieve objective assessment, tracking of instruments and force measurements are currently under development. The relation between these measurements and surgical performance has to be determined.

2. Improving surgical instruments. Most instruments used during surgery have many limitations. Several possibilities exist to improve current instruments or develop new instruments

3. Improvement of ergonomics. The ergonomic conditions under which a surgeon has to work are not perfect. New techniques should be developed to improve ergonomics.

Interesting traineeships and Master's thesis projects are available for each line of research. Please contact either F.W. Jansen or the responsible professor of your specialisation for more information.

6.3 EDUCATION IN ROTTERDAM

Erasmus MC offers a number of courses during the first year and courses, traineeships and graduation projects during the second year. A traineeship of 10 credits, a literature study of 10 credits (preferably on the same topic as the final research project) and a research project of 40 credits can be completed at the Erasmus MC.

You can choose from a number of courses, which can be followed either in the first Master's year or as part of the traineeship in the final year of the Master's programme in Biomedical Engineering. Graduation projects, literature

studies and traineeships can be performed in several research groups at the Erasmus MC. Below follows a short description of the courses and the groups, for more and/or more recent information: read the BME Master information on Blackboard.

You can register for these courses via Blackboard (or, if you do not succeed in registering via Blackboard, by sending an e-mail to Dr. Ir. J. van der Linden (j.vanderlinden@erasmusmc.nl), coordinator of education for BME students at the Erasmus MC.

6.3.1 COURSES

Technology modules

In Rotterdam, small technology modules of 1 credit are offered that teach an essential technological aspect of medical research (kvr1 to kvr7, see the detailed course descriptions at the end of this guide). These short courses can be followed all year round. The specific time frame and requirements for each course have to be arranged with Jacqueline van der Linden (j.vanderlinden@erasmusmc.nl). The courses are given to 2-4 students at the same time (depending on the specific module), if you subscribe alone, you will be added to a group. Registration for these short courses must take place at least 4 weeks in advance.

Medical course

In addition to these courses, there is a general medical course (7 credits, kvr7) on "Disorders of Environment & Interior". This course is given at the Erasmus University in the first semester of each year and covers the anatomy and physiology of some organ systems (e.g. lung, kidney and bladder). Since this course is also part of the general medical training programme, it stimulates interaction between medical students/colleagues.

For course descriptions see the Digital Study Guide on www.tudelft.nl/sis chapter Elective Courses Leiden / Rotterdam

6.3.2 TRAINEESHIPS AND MASTER'S THESIS ASSIGNMENTS

As indicated in Chapter 5, there is an intensive collaboration between the six BME specialisations and several groups in Rotterdam. In order to provide you with a compact overview of which Rotterdam groups might provide interesting traineeships or final Master's assignments for the BME specialisation that you have chosen, we first present a cross table here.

CROSS TABLE

Table VIII: Cross table indicating collaboration between Erasmus MC research groups and the six Biomedical Engineering specialisations in Delft[1]

	MIMS	BM	TBI	MI	CP	BMI
Thorax Centre	X			X	X	X
Orthopaedic Res. Lab.			X	X	X	X
Imaging				X		
Radiotherapy	X	X		X	X	
Ophthalmology		X				

1MIMS = Medical Instruments and Medical Safety; BM = BioMechatronics; TBI = Tissue Biomechanics and Implants; MI = Medical Imaging; CP = Clinical Physics; BMI = BioMedical Instruments

DESCRIPTION OF RESEARCH GROUPS

Biomedical Engineering of the Thorax Centre

Prof. Dr. Ir. Anton F.W. van der Steen, Prof. Dr. Ir. Nico de Jong

Contact: a.vandersteen@erasmusmc.nl

Website: www.thoraxcentre.nl

Biomedical Engineering of the Thorax Centre hosts a number of research lines which all have in common that they focus on research towards applications in Cardiology. The horizon for these applications varies from 2 months to 15 years. The following research themes can be identified:

1) Intravascular techniques: Catheter-based interventions play an important role in modern cardiology. Intravascular Ultrasound is a catheter-based technique that allows diagnosis and therapy guidance of atherosclerotic plaques. Several projects aim at detection of atherosclerotic plaque that is non-significant occluding, but that still can cause myocardial infarction by creating a thrombus after rupture.

2) Ultrasound Contrast Agents: These are micron-sized gas bubbles with a thin shell. They are strong reflectors and can thus be used as contrast agents. Research aims at understanding these bubbles by computer modelling, measurements and optical observations using a fast framing camera www.brandaris128.nl), developing detection strategies, and guiding clinical implementation. Furthermore the possibilities to use these contrast agents for local drug delivery are investigated.

3) Ultrasound Transducers: Ultrasonic imaging is performed by applying short electrical pulses to an ultrasound transducer. This transducer converts the electrical energy into acoustical energy. Commercially available transducers are hampered in their applicability. Several projects focus on developing dedicated transducers for special applications

4) Hemodynamics: The Hemodynamics laboratory studies the effects of mechanical stresses on the development of atherosclerosis and on wall healing after interventions in arteries of patients. Insight into these processes helps to improve selection, diagnosis and treatment of patients with atherosclerosis.

5) Experimental biomechanics: The group of vascular biomechanics studies the role of biomechanical factors in vascular biology. To that end we combine techniques from molecular biology with biophysics. This allows us to study the mechanism underlying the effect of biophysics on vessel remodelling, gene expression, and protein function. The focus is on the (biological) roles of shear stress and wall stress in atherosclerosis.

Orthopaedic Research Laboratory

Prof. Dr. Ir. Harrie Weinans; Dr. Ir. Jacqueline C. van der Linden; Prof. Dr. Jan A.N. Verhaar; Dr. Gerjo J. V.M. van Osch

Contact: h.weinans@erasmusmc.nl
Website: www2.eur.nl/fgg/orthopaedics/
Graduation projects: for more detailed information, contact the group members listed above. Examples of subjects: mechanical stimulation of bone, cartilage or tendon; evaluation of bone turnover and the role of micro-architecture in osteoporosis; tissue engineering of bone and cartilage and bioreactor developments; improved diagnostics and the role of subchondral bone in osteoarthritis. The various projects utilise advanced techniques from cell and molecular biology and/or imaging methods (e.g. micro-CT).

Research lines

The Orthopaedic Research Laboratory is part of the department of Orthopaedics of the Erasmus MC. Research is aimed at a variety of topics related to orthopaedic surgery or basic research. There is a main interest in diseases of bones and cartilage such as osteoporosis and osteoarthritis ('artrose'). The research concerns the full translation from basic research involving cell culture methods and animal experiments to clinical methods involving the development of new diagnostic methods or clinical evaluations.

The following main topics can be identified.

1) Imaging of skeletal tissue. In this area mostly micro-CT is used to evaluate bone and cartilage pathology in either human samples or animal experiments. In-vivo micro-CT is used in animal models of osteoporosis and osteoarthritis in combination with novel disease intervention methods.

2) Tissue engineering of skeletal tissues. The major goal in this line of research is to improve methods of tissue engineering to generate new tissues that can replace (parts of) skeletal tissues of the human body. A variety of cell, molecular and bioreactor approaches are used to improve and optimise the cell culture methods for skeletal tissue engineering.

3) Mechano stimulation of skeletal tissues. Physical stimuli have an important effect on growth, development, maintenance and ageing of tissues. In this line of research we try to identify which physical signals are potent stimuli for skeletal maintenance or repair. Cell cultures and animal experiments are used for human disease models and to study general aspects of skeletal (cell) physiology.

Biomedical Imaging Group Rotterdam
Prof. Dr. Ir. A. Vossepoel; Prof. Dr. W. Niessen
Contact: a.vossepoel@erasmusmc.nl
Website: www.bigr.nl

Graduation projects: contact Prof. Vossepoel/Prof. Niessen
The Biomedical Imaging Group Rotterdam (BIGR) is a joint initiative of the Departments of Medical Informatics and Radiology of the Erasmus MC. Through innovative fundamental and applied research it aims to develop and validate advanced techniques for the processing and analysis of large, complex, and heterogeneous medical and biological image data sets. The research of BIGR is organised in three main research lines, viz. cardiovascular image analysis, cellular and molecular image analysis and neuro image analysis.

Cardiovascular image analysis
Vascular imaging has gone beyond the traditional depiction of vascular luminal morphology. State-of-the art imaging techniques have the potential of providing detailed information on the vessel wall, such as plaque composition, elastic wall properties, and even biochemical processes that take place in the plaque. In addition, dynamic and perfusion imaging can provide functional information, e.g. to determine the perfusion or motion of the heart, or to study tumour activity. Owing to the growing complexity and sheer size of cardiovascular data, in combination with the large increase in the number of studies in clinical practice and biomedical research, there is a strong and increasing interest in robust, automated processing tools to aid the analysis of these data. This research line aims to develop and evaluate novel image processing techniques for visualisation, quantification and integrated analysis of multimodal anatomical and functional cardiovascular imaging data.
Cellular and molecular image analysis
Progress in fluorescent probing and microscopic imaging has revolutionised biology in the past decade and has opened up the door to studying the structure and function of even single molecules. In addition, in-vivo molecular imaging is expected to have a large impact on clinical practice, as it can be used to study disease processes at the molecular and cellular level, for therapy, and therapy monitoring.

Generally, these imaging studies require the processing and analysis of huge amounts of (3D and 4D) image data, which at present is still done mainly by hand. Manual image analysis is very time-consuming (thus costly) and also potentially inaccurate and poorly reproducible. As a result, many biologically and clinically interesting questions are either left unaddressed or answered with great uncertainty. In an attempt to alleviate this problem, this research line aims to develop an automated image analysis technology with specific emphasis on accurate and reproducible analysis of cellular and molecular image sequences.

Neuro image analysis
MR brain imaging is widely used in basis scientific research and in clinical practice, as it is a technique that provides both anatomical and functional information in a non-invasive manner. In order to study brain morphometry and function and its relation to e.g. disease processes or patient characteristics, large imaging databases are often collected. In this research line, advanced techniques for the automated processing and analysis of such databases are developed.

Department of Radiation Oncology (Erasmus MC-Daniel den Hoed)
Prof. Dr. P.C. Levendag (Head), Prof. Dr. B.J.M. Heijmen (Research Director Medical Physics)
Contact: b.heijmen@erasmusmc.nl
Website: www.erasmusmc.nl/radiotherapie

The department of Radiation Oncology of the Erasmus MC is one of the largest radiotherapy centres in Europe with an internationally renowned research programme. Daily, around 400 cancer patients are treated with ten linear accelerators, including the robotic Cyberknife system.

A central research theme is the development, implementation and evaluation of new technology in radiotherapy treatments. Important subjects are image-guided radiotherapy (IGRT), including advanced (4D) imaging during treatment, and intensity-modulated radiotherapy (IMRT) with computer optimization of the (4D) dose delivery. There is also great interest in development of robotic treatment machines. The Medical Physics division, with about 45 employees, has a leading role in this research programme and is also responsible for the physics support of the radiotherapy treatments. PhD students, postdocs and computer scientists generally work on projects with external funding. Through the years, many physics students (TU and TH) have carried out a research project in the Medical physics division in order to obtain their BSc or MSc degree. The department has a four-year post-doctoral training programme for physicists specialising in radiotherapy physics. This programme is supervised by the Dutch Society for Medical Physics (NVKF) and results in a formal registration as medical physicist.

Ophthalmology (Strabismus & Amblyopia) Research Laboratory
Prof. Dr. Huib Simonsz; Ir. Sander Schutte
Contact: simonsz@compuserve.com, mail@schutte.ws

Research lines
Research lines concern the suspension of the eye in the orbit (How does the eye articulate in the orbit?) and, as a clinical research question, improvement of the precision of operations for strabismus. For better understanding of the suspension of the eye in the orbit the first finite element analysis model of the eye in the orbit has been made. For validation of the FEA model, new information is needed on the material properties of the tissues involved and the anatomy of the structures. To this end, corollary studies are performed on the material properties of orbital fat and other constituent components, whereas the anatomy of the orbit is reconstructed digitally (5 adult orbits and 8 embryonic heads) in high resolution based on high-resolution scanning of a very large series of orbital anatomy slices.
The deformation of the orbital fat during eye movements is analyzed with optical flow technique. Finally, a large structured analysis of strabismus surgery has been started, involving models, sensitivity analysis, surgical instrumentation and devices to obtain information about the properties of the oculomotor system of individual patients during surgery.

7. All BME Master's courses

7.1 INTRODUCTION

In addition to the mathematics and engineering courses, several specific BME courses are given at TU Delft. For each specialisation, there are several compulsory courses. In addition to these courses there are a number of elective courses. Some of these elective courses fit perfectly within a specialisation: these courses are indicated as recommended.

In addition to the BME courses given at TU Delft (Table IX), a number of biomedical and medical courses can be followed at Leiden University Medical Center and Erasmus Medical Center (Table X). These courses will provide an excellent medical basis for BME students. All listed medical courses taken from the Bachelor's programme in Leiden are given in Dutch, even if the course name is in English. At Erasmus MC in Rotterdam, kvr1 to kvr6 and kvr8 can be given in English, if necessary. Kvr7 is given in Dutch.

Important!
Students are allowed to choose a number of medical courses at LUMC (in Leiden most courses are taught in Dutch!!) and Erasmus MC (in Rotterdam, only kvr7 is taught in Dutch, the other courses, kvr1 to kvr6 and kvr8 are taught in English, when necessary) with a total of no more than 10 credits. Any additional credits will be added to the total of 120 credits needed to accomplish the MSc BME programme.

Important!
In Table IX, X, and XI a number of courses are recommended (indicated by the letter R). It seems logical, but be informed that these courses are not Compulsory, it is only a suggestion for you to take these courses. Please do not feel obliged to take them.

Important!
There are many more courses at TU Delft that you can include in your study programme than the elective courses (indicated by the letter E) in Table XI: it would simply be too much to include all TU courses in one table. If you would like to take some elective courses not listed in this table, please discuss this with the responsible professor of your specialisation.

7.2 BIOMEDICAL COURSES IN DELFT

Table IX: BME courses at TU Delft (C = compulsory; R = recommended; E = elective; -: not advised

Biomedical Engineering courses									
Course Code	**Course name**	**Lecture hours**	**EC**	**MIMS**	**BM**	**TBI**	**MI**	**CP**	**BI**
Et4363	Medical Technology I (Diagnostic devices) & Health Care Systems	3/3/0/0	5	C	C	C	C	C	C
wb2408	Physiological systems	0/4/0/0	3	C	C	C	C	C	C
wb2308	Biomedical engineering design	0/2/0/0	4	C	C	E	E	E	E
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	C	R	R	E	E	E
wb2407	Human movement control	0/4/0/0	4	R	C	C	-	-	-
wb2432	Biomechatronics	0/0/2/2	4	R	C	R	-	-	-
wb2431	Bone mechanics and implants	0/4/0/0	3	E	R	C	E	E	E
AP2231TU D	Medical Imaging	0/0/2/2	6	R	R	R	C	R	R
ap3361	Medical physics and radiation technology Imaging	0/0/2/2	6	-	-	-	E	C	E
ap3581	Medical physics and radiation technology Radiotherapy	0/0/2/2	6	-	-	-	E	C	-
et4130	Bio-electricity	0/3/0/0	3	E	E	E	R	R	C
wb2436-05	Bio-inspired design	0/0/4/0	3	R	R	E	-	-	-
Et4364	Medical Technology II (Therapeutical devices)	0/0/4/0	4	R	R	R	R	R	C
Total compulsory courses (EC)				**14**	**20**	**15**	**14**	**20**	**15**

(C: compulsory courses; R: recommended elective courses; E: elective courses; -: not advised)

Table X: BME and medical courses at LUMC and Erasmus MC. You can take 10 credits of these electives (R = recommended; E = elective)

Medical courses at LUMC and ErasmusMC										
Univ.	**Course code**	**Course name**	**Lecture hours**	**EC**	**MIMS**	**BM**	**TBI**	**MI**	**CP**	**BI**
Leiden	BM1020L	G1Zn: Zenuwstelsel	4-22 Dec. 2006	5	E	R	E	E	E	R
Leiden	BM1030L	B2IN: Introduction in the Neurosciences	22 Jan. 16 Feb. 2007	6	E	R	E	E	E	R
Leiden	BM1040L	B2IR1: Internal Regulation I	5-30 March 2007	6	R	E	E	E	R	R
Leiden	BM1050L	B3TC2: Medical Imaging Technology	11-22 Dec. 2006	4	E	E	R	R	E	E
Leiden	BM1060L	G2HB: Houding en Beweging	12-30 March 2007	4	E	R	R	E	E	E
Leiden	BM1070L	G1SR: Sturing en Regeling	12-30 March 2007	4	R	R	E	E	R	R
R'dam	BM1080R	Kvr1: Tissue engineering	start any time	1	E	E	R	R	E	E
R'dam	BM1090R	Kvr2: CT imaging in research and in the clinic	start any time	1	E	E	E	R	E	E
R'dam	BM1100R	Kvr3: Echography	start any time	1	E	E	E	R	R	E
R'dam	BM1110R	Kvr4: Radiotherapy imaging and physics	start any time	1	E	E	E	R	R	E
R'dam	BM1120R	Kvr5: Computer simulation methods of biological tissues or systems	start any time	1	E	E	R	R	E	E
R'dam	BM1130R	Kvr6: Strabismus surgery	start any time	1	R	R	E	E	E	E
R'dam	BM1141R	Kvr7: General Course on Disorders of Environment & Interior	Sept. - Oct. 2007	7	E	E	E	E	E	E
R'dam	BM1150R	Kvr8: Biomedical Image Processing	start any time	1	E	E	R	-	R	E
You may take no more than 10 credits from this list of medical courses.										
(C: compulsory courses; R: recommended elective courses; E: elective courses; -: not advised)										

Note:
KVR8 is only an elective for those students who have not followed the Advanced digital image processing course.

Note:
These medical courses are not taken into account when applying for the post-initial education programme for Clinical Physicist.

7.2 MATHEMATICS AND ENGINEERING COURSES

Table XI: Mathematics and engineering courses at TU Delft
(C = compulsory; R = recommended; E = elective; -: not advised)

Mathematics and Engineering courses									
Course code	**Course name**	**Lecture hours**	**EC**	**MIMS**	**BM**	**TBI**	**MI**	**CP**	**BI**
wb2301	System identification & parameter estimation	0/0/2/2	7	C	C	-	-	-	-
wb2303	Measurement techniques	0/0/2/2	3	C	E	E	E	E	E
wb2404	Man-machine systems	0/4/0/0	4	C	R	-	-	-	-
wbp202	Haptics system design	start any time	4	C	R	-	-	-	-
wb1413	Multibody dynamics B	0/0/2/2	4	R	C	R	-	-	-
sc4020	Control theory	4/0/0/0	6	R	C	-	-	-	-
wb1409	Theory of elasticity	2/2/0/0	4	-	-	C	-	-	-
in4086	Data visualisation	0/0/4/0	6				C	R	
in4085	Pattern recognition	2/2/0/0	6	E	E	R	C	E	E
et4283	Advanced Digital Image Processing	0/4/4/0	6	-	-	-	C	R	-
ap3472p	Image Processing Lab. Course	start any time	2	-	-	-	C	-	-
ap3351	Radiation technology and radiation detection	2/2/0/0	6	-	-	-	-	C	-
ap3371	Radiological health physics (+31 hours pract.)	3/3/0/0	6	-	-	-	-	C	R
et4248	Introduction to micro electronics	3/0/0/0	2	-	-	-	-	-	C
et4252	Analogue IC design	0/3/0/0	4	-	-	-	-	-	C
et4257	Silicon sensors	0/3/0/0	4	-	-	-	-	-	C
et8016	Structured electronic design	4/0/0/0	5	-	-	-	-	-	C
et8017	Electronic instrumentation 1	4/0/0/0	5	-	-	-	-	-	C
wb5414-03	Design of machines and mechanisms	2/2/0/0	3	R	E	-	-	-	-
ct5142	Comp. methods in non-linear mechanics	0/4/0/0	3	-	-	R	-	-	-
wi4014tu	Numerical analysis C2	2/2/0/0	5	-	-	R	-	-	-
ap3531	Acoustical imaging	2/2/0/0	6	-	-	-	R	-	-
ap3121d	Imaging systems	0/0/2/2	6	-	-	-	R	-	-
et4129	Physical measurement methods & image technology	0/3/0/0	3	-	-	-	E	R	-
et4258	Displays & actuators	0/0/4/0	4	-	-	-	-	-	R
et4249	Semiconductor comp. and technology	0/4/0/0	5	-	-	-	-	-	R
et4250	IC technology	0/0/4/0	4	-	-	-	-	-	R
Total compulsory courses (EC)				**18**	**17**	**4**	**20**	**12**	**20**
With electives and recommended courses up to at least 30 credits									
(C: compulsory courses; R: recommended elective courses; E: elective courses; -: not advised)									

8. Study and traineeship abroad

Study abroad offers a lot of attractive prospects. You become acquainted with a different (organizational) culture, 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 profit from it in your search for a proper 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 for 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 contribute 10 EC to your MSc programme.

To arrange everything you have to do a lot yourself. Therefore you have to take into account a preparation period of preferably a year, but at least half a year.

You may also contact the coordinator for International Exchange:

Mrs Mascha 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

9. Technical University Teacher Course (TULO)

Graduated Masters of Science in Biomedical Engineering have the opportunity of participating in a special course to become a high school teacher in science or mathematics.

There is a standard course, which includes 60 EC. A maximum of 30 of these ECs can be integrated in the MSc study programme, the other, at least, 30 EC have to be earned in a post-MSc course.

For more information on admission to the programme and the study programme, please contact the office of TULO.

Office of TULO
Faculty TBM
Jaffalaan 5
2628 BX Delft
Tel: +31 (0)15 27 82786 / 83768
E-mail: j.geerlings@tudelft.nl

10. Enrolling for courses and tests

10.1 TESTS
Usually it is necessary to enrol for modules and tests.

10.1 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.

10.2 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.

When first using TAS the student must choose a personal password. This can be done by putting the campus card in a card reader. At the faculty there are two card readers: one located near the Pallas/Parthemus computer room (4, 1st) and one located at Education and Student Affairs (8B, 2nd floor).

11. Pass rules and criteria for 'cum laude'

11.1 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.

11.2 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.

11.3 '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.

13. Organization

13.1 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

13.2 INTERFACULTY MASTER'S PROGRAMME

BioMedical Engineering is an interfaculty Master's programme. Three faculties collaborate in this programme: the Faculty of Applied Sciences, the Faculty of Electrical Engineering, Mathematics and Computer Science, and the Faculty of Mechanical, Maritime and Materials Engineering. The administration of the BME programme is held at the latter Faculty. By bundling the BME knowledge in these faculties, a broad BME programme could be realised. Additionally, there is close and intensive collaboration with clinical partners at Leiden University Medical Center (LUMC), Erasmus Medical Center Rotterdam (Erasmus MC), and Academic Medical Center Amsterdam (AMC). The clinical partners participate in the teaching process in the first MSc year (LUMC and Erasmus MC), and in the tutoring process of the MSc projects in the second year (LUMC, Erasmus MC, and AMC).

13.3 DELFT CENTER OF BIOMEDICAL ENGINEERING

In the Delft Center of Biomedical Engineering many research groups with applications in the biomedical engineering field collaborate. There is an annual two-day symposium during which the PhD students present their work. The clinical partners are also invited to this symposium which is an excellent meeting place to start new and innovative research projects.

13.4 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

13.5 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
Prof.dr. F.C.T. van der Helm
Tel: +31 (0)15 27 85616
E-mail: F.C.T.vanderHelm@3me.tudelft.nl

Secretary
Mrs D. Heersma
Mekelweg 2
kamer 8C-1-18
2628 CD Delft
Tel: +31 (0)15 27 86400
E-mail: D.Heersma@3me.tudelft.nl

13.6 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. F.C.T. van der Helm
Tel: +31 (0)15 27 85616
E-mail: F.C.T.vanderHelm@tudelft.nl

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

13.7 STUDENT SOCIETY

The Master's programme has an active student society "Antonie van Leeuwenhoek". This society organises meetings, break-out sessions, and other social events on a regular basis.

13.8 STUDENT GUIDANCE

MSC COORDINATOR

The MSc coordinator is the person for questions or problems related to the individual study programme and for monitoring progress.
Every student should consult the MSc coordinator before the end of the first semester to set up an individual study programme using the following ingredients: compulsory courses, current ideas about the theme of the thesis project, the Specialisation Courses that bridge the gap between the compulsory courses and the thesis project and the use of the free elective space. The student submits his/her plan for approval to the Board of Examiners.
In order to finish the programme in two years, the student should plan to take an average of 30 credits worth of courses per semester. At the end of the first year, the student and the MSc coordinator will discuss his/her progress and planning.

The MSc coordinator is dr. ir. Edward Valstar
Tel: +31 (0)15 27 89530
E-mail: e.r.valstar@tudelft.nl

STUDY ADVISER

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

13.9 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

13.10 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)

13.11 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.

13.12 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 telephones provided throughout the faculty.

It is not allowed to:

- Damage or disable facilities.
- Use available facilities in any other way than their intended use: downloading, 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.

14. 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.).

14.1 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

14.2 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.

14.3 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

14.4 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.

Materials Sciences Laboratory
Contact Laboratory manager: To be announced
Tel: To be announced
Location: To be announced

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 of 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

14.5 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

14.6 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.

14.7 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.

15. 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

16. Course and Examination Regulations and 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

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