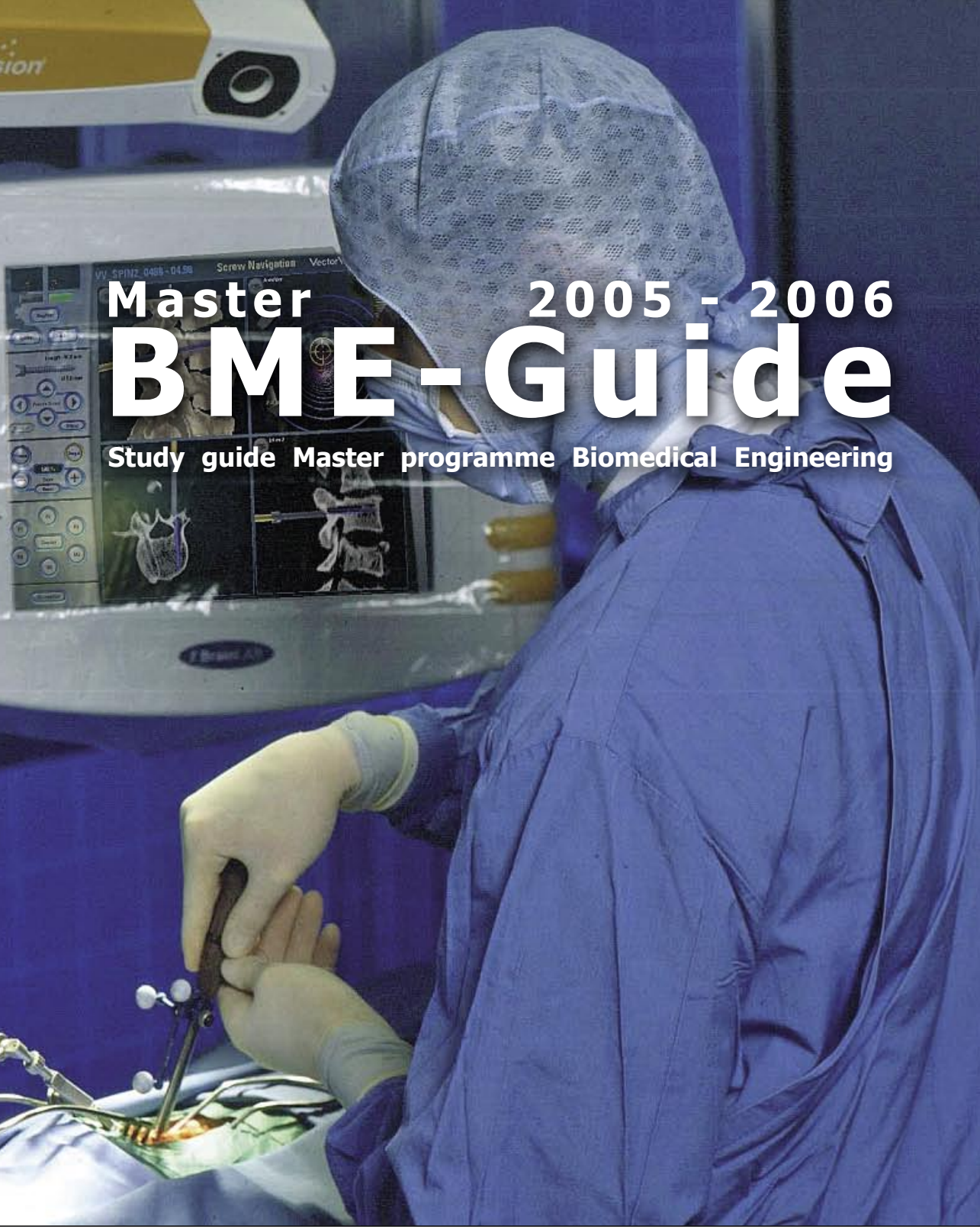

Master 2005 - 2006
BME-Guide

Study guide Master programme Biomedical Engineering

TU Delft

Academic Calendar 2005-2006

ACTIVITY	WEEK		DATE
1a	1	36	05-09-05
	2	37	12-09-05
	3	38	19-09-05
	4	39	26-09-05
	5	40	03-10-05
	6	41	10-10-05
	7	42	17-10-05
	8	43	24-10-05
	9	44	31-10-05
1b	1	45	07-11-05
	2	46	14-11-05
	3	47	21-11-05
	4	48	28-11-05
	5	49	05-12-05
	6	50	12-12-05
	7	51	19-12-05
		52	26-12-05
		1	02-01-06
	8	2	09-01-06
	9	3	16-01-06
	10	4	23-01-06
	11	5	30-01-06
2a	1	6	06-02-06
	2	7	13-02-06
	3	8	20-02-06
	4	9	27-02-06
	5	10	06-03-06
	6	11	13-03-06
	7	12	20-03-06
	8	13	27-03-06
	9	14	03-04-06
2b	1	15	10-04-06
	2	16	17-04-06
	3	17	24-04-06
		18	01-05-06
2b	4	19	08-05-06
	5	20	15-05-06
	6	21	22-05-06
	7	22	29-05-06
	8	23	05-06-06
	9	24	12-06-06
	10	25	19-06-06
	11	26	26-06-06
	12	27	03-07-06
		28	10-07-06
		29	17-07-06
		30	24-07-06
		31	31-07-06
		32	07-08-06
		33	14-08-06
		34	21-08-06
		35	28-08-06

legenda	
1a	Lectures, projects
	Examinations
	Holiday
	White weeks

14-04-06	Easter Friday
17-04-06	Easter Monday
25-05-06	Ascensionday
05-06-06	Whitsuntide
18.8.06	1st day examination period
31.8.06	last day examination period

BME - Guide

Master 2005 - 2006

BME-Guide

Study guide Master programme Biomedical Engineering

Colophon

Text	Education Support Staff 3mE
Prepress	Multimedia Services TUD
Press	Deltahage, Den Haag
July 2005	Edition of 400 pieces

Preface

We are very happy that per 1 September 2005 the MSc program on Biomedical Engineering will start for the second year. The first year has brought us many pleasant moments. The enthusiasm of the first class of 30 students was overwhelming and encouraging. Most of them really did find the study that they were looking for: Challenging, interesting, relevant, multi-disciplinary, application-oriented, etc.
We certainly hope that in the second year the study program will even become better. Of course, many small annoyances hopefully have been corrected. The unique collaboration in an interfacultary MSc program between the Depts of Applied Sciences, Electrical Engineering and Mechanical Engineering has its 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 into 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. The coming year many BME students will do their MSc thesis assignment, or at least part of it, at the premises of Leiden and Rotterdam.
In order to illustrate the good collaboration, last year also medical students have come to Delft, 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 do part of their study in Delft.
The BME program at Delft University of Technology is different from the other BME programs offered in the Netherlands, because it focuses on the education of good engineers within the traditional engineering disciplines, but who can apply their skills within a multi-disciplinary team of researchers, in which also medical scientists will 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.

In the field of Biomedical Engineering there are still many things to discover and there is a continuous quest for better devices. It is a hi-tech field in which research programs in universities still can compete (and collaborate!) with industrial programs. 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 oncoming year and many new opportunities for students, researchers and clinicians!

Prof.dr. Frans C.T. van der Helm

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MSc programme

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, Maritime and Materials Engineering. 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 in the first MSc year (LUMC and Erasmus MC), and in the tutoring 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 centers, biomedical engineers participate in research and education. Two examples are biomechanical research focussed at the improvement of joint replacement prostheses at a department of Orthopaedics, and image processing research for the automated detection of narrowing of 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-Bachelors with another degree can also enter the programme, however, after having done some additional courses. Bachelors with a degree of a Dutch polytechnic school (In Dutch: Technische Hogeschool) may also enter the programme with a number of additional courses: the Pre-Master programme.

1.1 Goal

The goal of the master programme in Biomedical Engineering is to educate academic engineers, who are technically high-skilled and have additional medical and biological knowledge. The engineer should be able to understand medical literature, and to develop conceptual models from a technical perspective.
Additionally, these engineers are able to collaborate with physicians, researchers and other health care professionals in order to identify, define and analyse biomedical problems, for the solution of which Biomedical Engineering principles and techniques can contribute; to design and produce a sound solution to the problem; and to present these solutions effectively. Most innovative solutions in biomedical engineering are due to

engineers and physicians, who have excellent skills in their own discipline, but who are also able to collaborate in multi-disciplinary teams.
Because of the multi-disciplinary nature of Biomedical Engineering, the concept of clinically driven research is a central theme in the master programme. In clinically driven research the engineer must communicate with the medical doctors about the nature of the clinical problem, and find a technical solution to solve the problem. In contrast, it has happened too often that a high-tech solution is not implemented because the wrong problem was solved.

1.2 Qualifications of the graduated MSc BME

The graduated Master of Biomedical Engineering meets, to a sufficient level, the following qualifications:

1. Broad and profound knowledge of engineering sciences (applied physics and mathematics) and the capability to apply this knowledge at an advanced level in the variant-related discipline.
2. Broad and profound scientific and technical knowledge of the variant-related 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 in part the forefront of scientific or industrial research and development. The knowledge is the basis for innovative contributions to the discipline in the form of new designs or development of new knowledge.
3. Thorough knowledge of paradigms, methods and tools as well as the skills to actively apply this knowledge for analysing, modelling, simulating, designing and performing research with respect to innovative variant-related systems, with an appreciation of different application areas.
4. Capability to independently solve 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 lacking expertise, monitoring and critically evaluating existing knowledge, planning and executing research, adapting to changing circumstances, and integrating new knowledge with an appreciation of its ambiguity, incompleteness and limitations.
5. Capability to work both independently and in multidisciplinary teams, interacting effectively with specialists and taking initiatives where necessary.
6. Capability to effectively communicate (including presenting and reporting) about one's work such as solutions to problems, conclusions, knowledge and considerations, to both professionals and non-specialised public in the English language.
7. Capability to evaluate and assess the technological, ethical and societal impact of one's work, and to take responsibility with regard to sustainability, economy and social welfare.
8. Attitude to independently maintain professional competence through life-long learning.

1.3 Study programme

1.3.1 Introduction

Biomedical Engineering is an academic master 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 needs to make a choice for a specialisation.

1.3.2 General information

1.3.2.1 Semesters and periods

Each course year is divided in 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 are scheduled.

1.3.2.2 Examinations

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

1.3.2.3 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 EC. One EC involves approximately 28 hours of study. The study load includes all time spent on the course: lectures, self study, traineeship, practical assignments, examinations, etc.
The study programme involves two years of study, each with a study load of 60 EC. The total programme is 120 EC.

1.3.3 The first MSc year (60 EC)

In the first year, students are expected to take at least 30 EC in biomedical courses, and at least 30 EC in fundamental technical courses. Biomedical courses consist of medical, medical technology, and biophysics courses.
For the biomedical courses as well as for the fundamental technical courses there is an obligatory part – specific for each specialisation – and there is an elective part that has to be chosen in agreement with the professor responsible for the specialisation (see paragraph 1.7: 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 EC.
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 do part of their study, e.g. the traineeship, abroad. For more information look at "Chapter 9: Study and traineeship abroad" of this guide.

1.3.4 The second MSc year (60 EC)

The second year will start with a traineeship in a biomedical research group or biomedical company. Bachelors from a polytechnic school (TH) get dispensation for this traineeship. Thereafter, a literature survey will be done and a master thesis project will be carried out. The order of traineeship and literature survey can be switched.
In general the assignments are carried out individually. It is most efficient if the literature survey, traineeship and the master thesis project are done in the same field of research. In order to assure the multi-disciplinary nature of the BME education, the master thesis project will be tutored by a technical as well as a clinical staff member.
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 thesis assignments will be presented. The exact date will be announced on the Biomedical Engineering community on Blackboard.

1.3.4.1 Traineeship in a hospital, industry or other research institute (10 EC)

During the traineeship a project task defined in consultation with the host institute should be done. For Dutch students, it is recommended to do the traineeship abroad. The will support initiatives for that purpose, or will actively help to find host institutes. The traineeship should be finished with a report.

Usually, the traineeship is arranged via one of the staff members of the chosen specialisation. Additionally, the Information Centre of the Student Facility Centre offer a lot of information, not only on a large number of companies abroad, but also on financially related affairs, working permits, visa, etc. Additional information is available at the website: http://www.sfc.tudelft.nl.
You may also contact the coordinator for International Exchange:
Mrs Mascha Toppenberg
Room 8C, ground floor
Mekelweg 2
2628 CD Delft
Phone: 015 27 86959
Fax: 015 27 88340
E-mail: m.p.i.toppenberg@3me.tudelft.nl

1.3.4.2 Literature survey (10 EC)

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

1.3.4.3 Master thesis project (40 EC)

The Master 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 presented. 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.
An overview of master assignments will be published on the BME site (www.bme.tudelft.nl)

1.3.4.4 Oral presentations

In multi-disciplinary research it is essential that students 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. For each presentation a grade will be given: One for the literature seminar, one for the seminar given six weeks after the start of his master assignment (introductory seminar), and one at the end of his master thesis project (graduation seminar). The seminars will be organised centrally for all Biomedical Engineering students. For all Biomedical Engineering students, in their final year it is compulsory to attend these seminars.

1.3.5 Student interviews

We feel that it is essential that a student knows what is expected from him, and that we learn from the student if there are any problems within the study programme, so we can make improvements.
At the beginning of the academic year, a central presentation will be given where we will give the new students a thorough introduction about the BME programme, and where the new students can meet each other.
Thereafter, before October 15, a personalised education programme will be established in discussion with the study coordinator (Dr. ir. Edward Valstar). This programme will have to be approved by the professor responsible for the chosen specialisation, and by the examination board.
In addition, yearly an official student interview is planned for each student. This interview is intended to discuss study progress and to get feedback on the study programme.
A questionnaire will have to be filled out by the student (anonymously) and based on the results of the questionnaires action can be taken to improve courses.

1.4 Specialisations within the MSc BME programme

1.4.1 Introduction

The programme is divided in 6 specialisations, which are discribed in the following paragraphes

1.4.2 Specialisation Medical Instruments & Medical Safety (MIMS)

Responsible professor: Prof.dr.ir. Peter A. Wieringa
(tel. 015-2785763; e-mail: p.a.wieringa@3me.tudelft.nl)
Prof. dr. Jenny Dankelman, Prof.dr.ir. Cees A. Grimbergen

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

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 health care delivery. The 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. In the field of colonoscopy a new locomotion system is developed 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 directed to the medical specialisations of surgery, cardio-vascular diseases and gastroenterology.

1.4.3 Specialisation Biomechatronics (BM)

Responsible professor: Prof. dr. Frans C.T. van der Helm
(tel. 015-2785616; e-mail: f.c.t.vanderhelm@3me.tudelft.nl))

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

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 healthy 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 electromechanical 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 existed 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 stroke and patients with trauma of the central nervous system.

1.4.4 Tissue Biomechanics and Implants (TBI)

Responsible professor: Prof. dr .ir. Fred van Keulen
(tel. 015-2786515; e-mail: f.vankeulen@3me.tudelft.nl),
Dr. ir. Jacqueline van der Linden

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

Despite the long experience in joint replacement prostheses (the first were implanted in the 1960's), 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 fail frequently. To improve these prostheses, a close cooperation between the medical and technical profession is essential.
In this master 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 in aging and 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 loose 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. In 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.

1.4.5 Medical Imaging (MI)

Responsible professor: Prof. dr. Albert Vossepoel
(tel. 015-2782033; e-mail: A.M.Vossepoel@tnw.tudelft.nl

Quantitative Imaging Group, Faculty of Applied Sciences

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 in providing user interface and visualization 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 judgment of the radiologist or other medical specialist. When the images have been acquired with different imaging methods, or on different moments, it is necessary to match or register the individual images, before they can be fused, or subtracted from each other.
Intelligent utilization 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, a 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 are in medical research, clinical support, and with suppliers and manufacturers of the various devices for acquisition and processing of medical images, mainly directed to radiology.

1.4.6 Clinical Physics (CP)

Responsible professor: Prof. dr. ir. C.E. van Eijk
(tel.: 015-2786559; e-mail: C.W.E.vanEijk@IRI.TUDelft.nl)
Dr. J. Zoetelief

Interfaculty Reactor Institute (IRI), Faculty of Applied Sciences

Clinical physics is a specialisation that is strongly developing in recent years. On one hand this is due to the ever-increasing application of physical methods in health care. On the other hand it appears that clinical physicists are valuable partners in a discussion among the various professionals working at health care institutions.
Clinical physicists are responsible for the standardisation and calibration of the medical instrumentation, in close co-operation 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 upon 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. In 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 a MSc thesis project. This will, generally, be carried out at a hospital and be tutored by a staff member of Delft University of Technology and a staff member from the hospital.
Negotiations with representatives of the Netherlands Society of Clinical Physics (NVKF) concerning admittance to the in service education on clinical physics are in advanced stage. It is anticipated that the BME CP education (bachelor physics (major) followed by master biomedical engineering - clinical physics) is expected to be sufficient for admission to the selection procedure for a position at an in service education on clinical physics. The BME CP education may lead to a reduction in the length of the in service education on clinical physics (eventual dispensation is subject to negotiation with the NVKF).

1.4.7 Biomedical Instrumentation (BI)

Responsible professor: Prof. dr. ir. Paddy French
(tel. 015-2784729; e-mail: P.J.French@EWI.TUDelft.NL)

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

Within the department of Microelectronics biomedical research activities are directed towards sensor Microsystems in the Laboratory for Electronic Instrumentation and low-voltage, low-power electronics in the Laboratory for Electronics.
The mission in 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 the 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-less 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.

1.5 Admission

1.5.1 Introduction

In the following sections the admission requirements one given. The following situations may arise:

- Admission without additional requirements.
- Admission with additional requirements of no more than 15 EC.
  The additional requirements in Bachelor courses can be part of the elective courses of the chosen specialisation in the master programme.
- Admission with additional requirements between 15 and 45 EC.
  In this case 15 EC are part of the 120 EC of the normal MSc-program and 30 EC at most are additionally required above the standard MSc-program.
- No admission (additional requirements are more than 45 EC).
  The candidate has to obtain a relevant Bachelor-degree first.

1.5.2 Admission for students with an academic Bachelor

1.5.2.1 Introduction

Students holding an academic Bachelor degree in Physics of a Dutch university, or a Bachelor degree in Biomedical Engineering (BME), Applied Physics (AP), Mechanical Engineering (ME), Electrical Engineering (Et), Areospace Engineering (AE), Marine Technology (MT), Industrial Design Engineering (IO) and Civil Engineering (CE) of 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 program with additional requirements.
However, it is important to note that although there are no formal additional requirements, it might be necessary to take some Bachelor 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 as laid down in the following tables.

Table I Additional Bachelor courses for admission to Medical Instruments and Medical Safety (MIMS) and Biomechatronics (BM)

Table I: Overview of additional Bachelor 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 EC points[1].

Course Code	Course Name	BME	AP	ME	Et	AE	MT	IE	CE
wb1216	Dynamics 2	3	3		3		3	3	3
wbtp209	Mechatronics	10	10		10		10	*	10
sc4140ap	Control Engineering	5	5						
wb2104	Systems & Control Engineering 1								3
wb2207	Systems & Control Engineering 2					3	3	3	3
wi2051wbmt	Differential equations							3	
wi2252wbmt	Analysis 3							3	
	Total EC	**18**	**18**	**None**	**13**	**3**	**16**	**12**	**16**

* Instead of taking this course of 10 EC, students with a Bachelor in Industrial Design Engineering need to take the course "Inleiding Mechatronica of in the first MSc year of BME. This course is compulsory within the elective part of the BME programme.

Table II Additional Bachelor courses for admission to Tissue Biomechanics and Implants (TBI)

Course Code	Course Name	BME	AP	ME	Et	AE	MT	IE	CE.
wb1216	Dynamics 2	3	3		3			3	3
wb1311	Mechanics 3	4	4		4		4	4	
wb1212	Finite Element Methods 1	3	3		3			3	
wb1213-03	Elasticity	2.5	2.5		2.5			2.5	
wb1214	Finite Element Methods 2	1.5	1.5		1.5			1.5	
sc4140ap	Control Engineering		5						
wb2104	Systems & Control Engineering 1								3
wb2207	Systems & Control Engineering 2	3				3	3	3	3
wi2051wbmt	Differential Equations	3						3	
wi2252wbmt	Analysis 3	3						3	
	Total EC	**23**	**19**	**None**	**14**	**3**	**7**	**23**	**9**

Table III Additional Bachelor courses for admission to Medical Imaging (MI) and Clinical Physics (CP)

Course Code	Course Name	Biomed. Eng.	Appl. Phys.	Mech. Eng.	Elec. Eng.	Aer. Eng.	Mar. Tech.	Math. or Comp. Science	Civ. Eng.
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 EC	**24**	**none**	**21**	**10**	**21**	**21**	**24**	**24**

1.5.2.1 Additional Bachelor 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 should show that they have at least 13 EC 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.

1.5.3 Admission for students with a Bachelor at a Dutch polytechnic school (TH)

1.5.3.1 Introduction

Candidates having a Bachelor 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-Bachelors program within 4 years, with good results.
An, pre-Masters programme, of approximately 30 EC needs to be completed before the candidate is formally admitted to the MSc-program. In the pre-Masters programme, a number of courses of the second year of the academic Bachelor-programme has to 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-programme that forms the basis for the specific specialisation. The head of the chosen specialisation may require that also a number of third year courses of the Bachelor-programme are followed.

All courses of the pre-Master programme are in Dutch.
Candidates are formally admitted only to the pre-Master-programme. However, both the pre-Master-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 programme has to be approved by the Examination Committee.

The total study load for Bachelor students from a polytechnic school contains: 120 EC -/- 10 EC (dispensation traineeship) + pre-master programme (approx 30 EC) = 110 EC + approx 30 EC (pre-master programme)

1.5.3.2 Pre-master 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.

Table IV: Pre-master programme Mechanical Engineering / Aerospace Engineering / Human Motion Technology.

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
wb1212	Eindige elementen. Methode 1	3
wb1213-03	Elasticiteitsleer	2.5
wb1214	Eindige elementen methode 2	1.5
wb1216 [1)]	Dynamica 2	3
wb2207 [1)]	Systeem- en regeltechniek 2	3
	Total	**28**

1.5.3.3 Pre-master programme for Medical Imaging (MI) and Clinical Physics (CP)

In these two specialisations, Bachelors with a TH-degree in Applied Physics can enrol.

Table V: Pre-master 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**

1.5.3.4 Pre-master programme for Biomedical Instruments (BI)

In this specialisation, students with a polytechnic Bachelor in Electrical Engineering can enrol.

Table VI: Pre-master 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 dependent on the exact bachelor programme that has been taken	
	Total	**30**

1.5.4 Admission for students that are still in their academic Bachelor programme

A student that hasn't finished the Bachelor programme is permitted to do examinations in the MSc-programme, if the examination committee approves. When the student has passed the propaedeutic examination and has a study result of the second and third year of at least 100 EC, including the Bachelor thesis, the student can be conditionally admitted to the MSc-program, to take part in examinations of a few MSc-courses. Final admittance is granted after completing the Bachelor programme.

1.6 Education in Leiden (LUMC) and Rotterdam (Erasmus MC)

1.6.1 Introduction

Part of the master programme can be taken at Leiden University Medical Center, Erasmus Medical Center (Rotterdam). On one hand there are many possibilities to do an internship or to do your master thesis assignment in one of these two medical centers, on the other hand it is also possible to take a number of biomedical courses. In Leiden, the focus is on courses for the first master year (these courses are mainly given in Dutch, so they can not be taken by non-Dutch speaking students). In Rotterdam the focus is on courses in the second master year, although the courses can be taken separately in the first master year, they are also integrated in a traineeship programme that is offered.
Students are allowed to choose these medical courses at LUMC and Erasmus MC with a total of no more than 10 EC. Any additional EC points will come on top of the total of 120 EC needed to accomplish the MSc BME programme.

1.6.2 Education in Leiden

1.6.2.1 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.
At LUMC, education is based on "doelstellingengestuurd" 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 examined with a 3 hour written examination.
Detailed information on the courses and their time schedule can be found at http://www.lumc.nl/onderwijs.html. You can register for these courses by sending an e-mail to Edward Valstar, coordinator of the BME masters programme (e.r.valstar@3me.tudelft.nl). Registration has to take place at least 3 weeks in advance Each course has its own module at blackboard via which the course-coordinator communicates with the students. Therfore, students who have been granted admission to the courses will get access to the LUMC blackboard environment.
the course are given only in Dutch. See chapter 5 for course descriptions

1.6.2.2 Traineeships and master thesis assignments

Cross-table

There is an intensive collaboration between the six BME specializations and several groups in Leiden. In order to provide a compact overview of which Leiden groups might provide interesting traineeships or final master assignment for the BME specialisations a cross table is given a description of these groups.

Table VII: Cross table indicating collaboration between LUMC research groups and the six Biomedical Engineering specializations 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		

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
Homepage: www.lumc.nl/lkeb
Graduation projects: http://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 in six sections, of which four are dedicated to segmentation, quantification and visualization for specific applications: Intravascular Ultrasound, Cardiovascular Magnetic Resonance Imaging, Orthopaedics&Pulmonology and Neuro-image Processing. In two sections, research is performed mostly independent 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 Research 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
Homepage: www.lumc.nl/orthopaedics

The research of this group is focussed 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. These data can be used to predict and to evaluate the effect of surgical treatments.
2. Improvement of treatment of the pathological joint by 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).

For each line of research, interesting traineeships and master thesis projects are available. 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

Homepage: in progress

Graduation projects: contact Jurriaan de Groot.

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

1. Neuromuscular changes after 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 dept. of neurology (LUMC) and the Dept. 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 31P-NMR (nuclear magnetic resonance) of 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 dept. of Orthopaedic surgery this method is applied on 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
Homepage: http://www.lumc.nl/kno/algemeen/subspecialismen.html#1.

Cochlear implants are neuro-prosthetic devices that are widely used to rehabilitate deaf patients. With modern multi-channel devices most recipients are able 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 electro¬physiological 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 recognized 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 realized 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 continuously have direct impact on the clinical CI program 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 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 in patients with neurological disorders who also show motor dysfunctions, like patients with Parkinson's disease, CVA and Complex Regional Pain Syndrome. Clinical diagnosis of these patients is done using questionnaires and simple manual tests. There is an increasing desire for more objective tests for diagnosis, assess the disease progress and the effect of medication. In collaboration with the dept. of neurophysiology, rehabilitation medicine and Delft University of Technology a number of these tests are being developed or improved. E.g. for patients with symptoms of bradykinesia (dysfunction of fine motor coordination) a test is being developed to quantify the ability of fast finger and thumb motions. For

patients with Parkinson's disease and CRPS test 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 Gyneacology

Dr. F.W. Jansen
Contact: f.w.jansen@lumc.nl
Homepage: http://www.lumc.nl/3040/patientenzorg/endoscopie.html

The research of this group is focused on:

1. Training of surgeons. Development of measurement tools for objective assessment of surgical skills. At this moment training in the skills lab is not obligatory for two reasons. It is unknown what the required skills are and 2) current performance measurements are subjective. For training outside the OR box trainers and virtual reality trainers are available. Box trainers are hardly used because they are not challenging to use and objective assessment of performance 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 advances 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 situation under which surgeon has to work are not optimal. New techniques should be developed to improve ergonomics.

For each line of research, interesting traineeships and master thesis projects are available. Please contact either F.W. Jansen or the responsible professor of your specialisation for more information.

1.6.3 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 EC, a literature study of 10 EC (preferably on the same topic as the final research project) and a research project of 40 EC can be done at the Erasmus MC.
A number of courses can be chosen, which can be followed either in the first master year or as part of the traineeship in the final year of the masters program in Biomedical Engineering. Graduation projects, literature studies and traineeships can be performed in several research groups at the Erasmus MC.
You can register for these courses via blackboard (or, if you do not succeed in registering via bBackboard, 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.

Technology modules

In Rotterdam, small technology modules of 1 EC 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 the year round. The specific time frame and requirements for each course have to be arranged with the contact person of the course. 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 has to take place at least 4 weeks in advance.

Medical course

Besides these courses there is a general medical course (4 EC, kvr7) on "Disorders of Environment & Interior". This course is given each year at the Erasmus University, in the first semester 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 program it stimulates interaction with medical students/colleagues.
See chapter 5 for course descriptions

1.6.3.2 Traineeships and master thesis assignments

There is an intensive collaboration between the six BME specializations and several groups in Rotterdam. In order to provide a compact overview of which Rotterdam groups might provide interesting traineeships or final master assignments for the BME specialisations a cross table is presented and a description of the research group is given.

1.6.3.2.1 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 Center	X			X	X	X
Orthopaedic Res. Lab.			X	X	X	X
Imaging				X		
Radiotherapy	X	X		X	X	
Ophthalmology		X				

Biomedical Engineering of the Thorax Centre

Prof. dr. ir. Anton F.W. van der Steen, Prof. dr. ir. Nico de Jong
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homepage: http://www.thoraxcentre.nl

Biomedical Engineering of the thorax centre hosts a number of research lines that have all in common that they focus on research towards applications in Cardiology. The horizon for these application 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 allow 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: Ultrasonics imaging is performed by applying short electrical pulses to an ultrasound transducer. This transducer converts the electrical energy to acoustical. Commercially available transducers are hampered in their applicability. Several projects focus on developing dedicated transducers for special applications
4) Hemodynamics, In the Hemodynamics laboratory the effects of mechanical stresses on the development of atherosclerosis and on wall healing after interventions in arteries of patients is studied. Insight in 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 mechanism underlying the effect of biophysics on vessel remodeling, gene expression, and protein function. The focus is upon 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
homepage: http://www2.eur.nl/fgg/orthopaedics/Information.html

Graduation projects: for more detailed information: contact 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 utilize 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 bone 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 optimize 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 involved 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
homepage: 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 organized 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 to provide 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. for determining the perfusion or motion of the heart, or to study tumor 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 in the analysis of these data. This research line aims to develop and evaluate novel image processing techniques for visualization, quantification and integrated analysis of multimodal anatomical and functional cardiovascular imaging data.

Cellular and molecular image analysis

Advances in fluorescent probing and microscopic imaging have revolutionized biology in the past decade and have 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 in clinical practice, as it will be able to study disease processes at the molecular and cellular level, can be used for therapy, and therapy monitoring.
Generally, these imaging studies require the processing and analysis of huge amounts of (3D and 4D) image data, which is at present 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 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 non-invasively provides both anatomical and functional information. In order to study brain morphometry and function, and its relation to e.g. disease processes or patient characteristics, often large imaging databases are 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), Dr. B.J.M. Heijmen (Research Director Medical Physics)
contact: b.heijmen@erasmusmc.nl
homepage: http://www.erasmusmc.nl/radiotherapie
The department of Radiation Oncology of the Erasmus MC is one of the largest radiotherapy centers in Europe with **an internationally reknowned research program.** 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 optimisation of the (4D) dose delivery. There is also great interest in development of robotic treatment machines. The division of Medical Physics with about 45 employees has a leading role in this research program and is also responsible for the physics support of the radiotherapy treatments. PhD students, postdocs and computer scientists are generally working on projects with external funding. Through the years, many physics students (TU and TH) have performed a research project in the division of Medical physics to obtain their BSc or MSc degree. The department has a four-year post-doctoral training program for physicists specializing in radiotherapy physics. This program 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 aim corrollary studies are performed on the material properties of orbital fat and other constiuent components, whereas the anatomy of the orbit is reconstructed digitally (5 adult orbits and 8 embryonal 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 analysed with optical flow technique. Finally, a large structured analysis of strabismus surgery has been started, involving models, sensitivity analysis, surgical instrumention and devices to obtain information about the properties of the oculomotor system of individual patients at surgery.

1.7 BME master courses

1.7.1 Introduction

In additon to the mathematics and engineering courses, several specific BME courses are given at Delft University of Technology. For each specialisation, there are several courses that are obligatory. In addition to these courses there is 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 taken at Leiden University Medical Center and Erasmus Medical Center (Table X). All medical courses from the Bachelor programme in Leiden are given in Dutch. In Rotterdam at Erasmus MC kvr1 to kvr6 and kvr8 can be given in English, if necessary. Kvr7 is given in Dutch
Students have to take 30 EC biomedical or medical (LUMC and Erasmus MC) course and 30 EC of fundamental medical courses

1.7.2 DUT Biomedical courses

Table IX-MIMS:

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	MI & MS
et4126	Medical technology	3/0/0/0	4	o
et4128	Health care systems	3/0/0/0	3	o
wb2308	Biomedical engineering design	0/2/0/0	4	o
wb2408	Physiological systems	0/4/0/0	3	o
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	o
wb2407	Human movement control	0/4/0/0	4	r
wb2432	Biomechatronics	0/0/2/2	4	r
wb2436-05	Bio-inspired design	0/0/4/0	3	r
Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	MI & MS
wb2301	System identification & parameter estimation	0/0/2/2	7	o
wb2303	Measurement techniques	0/0/2/2	3	o
wb2309	Introduction specialisation MMS and BME	2/0/0/0	1	o
wb2404	Man-machine systems	0/4/0/0	4	o
wbp202	Haptics system design (fits best in period 2b)		4	o
wb1413-04	Multibody dynamics B	0/0/2/2	4	r
wb5414-03	Design of machines and mechanisms	2/2/0/0	3	r
		Total obligatory EC	**35**	

(o: obligatory courses; r: recommended elective courses)

Table IX-BM:

Specialisation BioMechatronics (BM)

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	BM
et4126	Medical technology	3/0/0/0	4	o
et4128	Health care systems	3/0/0/0	3	o
wb2308	Biomedical engineering design	0/2/0/0	4	o
wb2407	Human movement control	0/4/0/0	4	o
wb2432	Biomechatronics	0/0/2/2	4	o
wb2408	Physiological systems	0/4/0/0	3	r
wb2431	Bone mechanics and implants	0/2/2/0	3	r
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	r
wb2436-05	Bio-inspired design	0/0/4/0	3	r

Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	BM
sc4020	Control theory	4/0/0/0	6	o
wb1413-04	Multibody dynamics B	0/0/2/2	4	o
wb2301	System identification & parameter estimation	0/0/2/2	7	o
wb2309	Introduction specialisation MMS and BME	2/0/0/0	1	o
wb2404	Man-machine systems	0/4/0/0	4	r
wbp202	Haptics system design		4	r
wb2420	Modelling of dynamic systems	0/4/4/0	6	r
		Total obligatory EC	**37**	

(o: obligatory courses; r: recommended elective courses)

Table IX-TBI:

Specialisation Tissue Biomechanics and Implants (TBI)

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	TBI
et4126	Medical technology	3/0/0/0	4	o
et4128	Health care systems	3/0/0/0	3	o
wb2407	Human movement control	0/4/0/0	4	o
wb2408	Physiological systems	0/4/0/0	3	o
wb2431	Bone mechanics and implants	0/2/2/0	3	o
wb2432	Biomechatronics	0/0/2/2	4	o
in4085	Pattern recognition	2/2/0/0	3	r
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	r
Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	TBI
wb1409	Theory of elasticity	2/2/0/0	4	o
wb1440	Eng.optimization: concept and applications	2/2/0/0	3	o
ct5142	Comp. methods in non-linear mechanics	0/4/0/0	3	r
wb1413-04	Multibody dynamics B	0/0/2/2	4	r
wb2413-04	Instrumentation	0/0/2/2	2	r
wi4014tu	Numerical analysis C2	2/2/0/0	5	r
		Total obligatory EC	**28**	

(o: obligatory courses; r: recommended elective courses)

Table IX-MI:

Specialisation Medical Imaging (MI)

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	MI
ap3471p	Measurement in images		2	o

Course Code	Course name	Lecture hours	EC	MI
et4085	Image processing	0/4/0/0	4	o
et4126	Medical technology	3/0/0/0	4	o
et4128	Health care systems	3/0/0/0	3	o
in4085	Pattern recognition	2/2/0/0	3	o
et4130	Bio-electricity	0/3/0/0	3	r
Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	MI
ap3531	Acoustal imaging	2/2/0/0	6	o
ap3121d	Imaging systems	0/0/2/2	6	o
in4086	Data visualization	0/0/4/0	6	o
in4151	3D computer graphics and VR	2/2/0/0	6	o
		Total obligatory EC	**40**	

(o: obligatory courses; r: recommended elective courses)

Table IX-CP:

Specialisation Clinical Physics (CP)

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	CP
ap3361	Medical physics and radiation technology 1	0/0/2/2	6	o
ap3581	Medical physics and radiation technology 2	0/0/2/2	6	o
et4126	Medical technology	3/0/0/0	4	o
et4128	Health care systems	3/0/0/0	3	o
et4129	Physical measurement mehods & image techn.	0/3/0/0	3	r
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	r
Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	CP
ap3351	Radiation technology and radiation detection	2/2/0/0	6	o
ap3371	Radiological health physics (+31 hours pract.)	3/3/0/0	6	o
et4085	Image processing	0/4/0/0	4	r
in4008	Data visualization (+56 hours practical)	0/0/3/0	5	r
		Total obligatory EC	**31**	

(o: obligatory courses; r: recommended elective courses)

Table IX-BI:

Specialisation Biomedical Instrumentation (BI)

Specific Biomedical Engineering courses				
Course Code	Course name	Lecture hours	EC	BI
	Introduction clinical physics		0,5	o
et4126	Medical technology	3/0/0/0	4	o

et4128	Health care systems	3/0/0/0	3	o
et4130	Bio-electricity	0/3/0/0	3	o
wb2408	Physiological systems	0/4/0/0	3	o
ap3371	Radiological health physics (+31h pract.)	3/3/0/0	6	r
ide530	Biomechanics		3	r
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2	r
Mathematics and Engineering courses				
Course Code	Course name	Lecture hours	EC	BI
et4248	Introduction to micro electronics	3/0/0/0	2	o
et4252	Analogue IC design	0/3/0/0	3	o
et4257	Silicon sensors	0/3/0/0	3	o
et8016	Structured electronic design	4/0/0/0	3	o
et8017	Electronic instrumentation 1	4/0/0/0	3	o
et4249	Semiconductor comp. and techn.		4	r
et4250	IC technology		3	r
et4258	Displays & actuators		3	r
wm1109tu	Scientific writing and oral presentation		2	r
		Total obligatory EC	**27,5**	

(o = obligatory; r = recommended)

Table X: BME and medical courses at LUMC and Erasmus MC. Maximum 10 EC can be chosen (R = recommended; E = Elective)

	Course code	Course name	Lecture hours	EC	MI& MS	BM	TBI	MI	CP	BI
Leiden University Medical Center	BP031	Humane biologie	19/09 – 14/10	6	r	r	r	r	r	r
	M1822w	Zenuwstelsel	05/12 – 23/12	5	e	r	e	e	e	r
	BB050	Functional and Chemical Neuroanatomy	23/01 – 17/02	6	e	r	e	e	e	r
	BB290	Internal Regulation I	06/03 – 31/03	6	r	e	e	e	r	r
	BB311	Medical Imaging Technology	08/12 – 23/12	4	e	e	r	r	e	e
	M2831	Houding en Beweging	13/03 – 31/03	4	e	r	r	e	e	e
	M1860	Sturing en Regeling	13/03 – 31/03	4	r	r	e	e	r	r
		Mesenchymal differentiation and pathology of bone	Dec. 2005		e	e	e	e	e	e
Erasmus Medical Center	Kvr1	Histological techniques	start any time	1	e	e	r	r	e	e
	Kvr2	CT imaging in research and in the clinic	start any time	1	e	e	e	r	e	e
	Kvr3	Echography	start any time	1	e	e	e	r	r	e
	Kvr4	Radiotherapy imaging and physics	start any time	1	e	e	e	r	r	e
	Kvr5	Computer simulation methods of biological tissues or systems	start any time	1	e	e	r	r	e	e
	Kvr6	Strabismus surgery	start any time	1	r	r	e	e	e	e
	Kvr7	General Course on Disorders of Environment & Interior	Sept. 2005	4	e	e	e	e	e	e
	Kvr8	Kvr8 Biomedical Image Processing	start any time	1	e	e	r	r	r	e

1.7.3 Table XI Elective courses for all BME-specialisations

Obligatory courses of a specialisation in one of previous tables can also be chosen as elective course of another specialisation. This after consideration with the educational coordinator of BME

Biomedical Engineering Courses			
Course code	Course name	Lecture hours	EC
et4126	Medical technology	3/0/0/0	4
et4128	Health care systems	3/0/0/0	3
et4130	Bio-electricity	0/3/0/0	3
et4127	Theme course biomedical technology		3
et4129	Physical measurement mehods & image techn.	0/3/0/0	3
et4085	Image processing	0/4/0/0	4
in4085	Pattern recognition	2/2/0/0	3
	Introduction clinical physics		0,5
ap3471p	Measurement in images		2
ap3361	Medical physics and radiation technology 1	0/0/2/2	6
ap3581	Medical physics and radiation technology 2	0/0/2/2	6
ap3371	Radiological health physics (+31h pract.)	3/3/0/0	6
wb2308	Biomedical engineering design	0/2/0/0	4
wb2408	Physiological systems	0/4/0/0	3
wb2435-03	Surgical instruments and medical safety	2/0/0/0	2
wb2407	Human movement control	0/4/0/0	4
wb2432	Biomechatronics	0/0/2/2	4
wb2436-05	Bio-inspired design	0/0/4/0	3
wb2431	Bone mechanics and implants	0/2/2/0	3
ide530	Biomechanics		3
ide534	Ergonomical aspects data processing systems		2
ide5381	Design ergonomics for elderly & handicapped		3

Non-Biomedical Engineering Courses			
Course code	Course name	Lecture hours	EC
ap3531	Acoustal imaging		
ap3121d	Imaging systems		
ap3351	Radiation technology and radiation detection	2/2/0/0	6
et4004	EM radiation, scattering and imaging		3
et4083	Statistic signal processing		3
et4147	Signal processing for telecommunications		3
et4161	Information theory		3
et4235	Digital signal processing		2
et4251	HF silicon technology		3

Course code	Course name	Lecture hours	EC
et4253	Nanoelectronics & micropower design		3
et4256	Reliability engineering		3
et4260	Microsystems integration		3
et4248	Introduction to micro electronics	3/0/0/0	2
et4252	Analogue IC design	0/3/0/0	3
et4257	Silicon sensors	0/3/0/0	3
et8016	Structured electronic design	4/0/0/0	3
et8017	Electronic instrumentation 1	4/0/0/0	3
et4249	Semiconductor comp. and techn.		4
et4250	IC technology		3
et4258	Displays & actuators		3
wm1109tu	Scientific writing and oral presentation		2
ide521	Computer visualisation		3
in4006tu	3D computer graphics		4
in4017	Multimodal interfaces and VR		3
in4086	Data visualization	0/0/4/0	6
in4151	3D computer graphics and VR	2/2/0/0	6
in4008	Data visualization (+56 hours practical)	0/0/3/0	5
sc4020	Control theory	4/0/0/0	6
sc4070	Practical control systems	0/0/3/0	4
sc4100	Mechatronic design	2/0/0/0	3
sc4110	System identification B	0/0/2/2	5
sc4150	Fuzzy logic engineering applications	3/0/0/0	3
wb2301	System identification & parameter estimation	0/0/2/2	7
wb2303	Measurement techniques	0/0/2/2	3
wb2309	Introduction specialisation MMS and BME	2/0/0/0	1
wb2404	Man-machine systems	0/4/0/0	4
wbp202	Haptics system design		4
wb1413-04	Multibody dynamics B	0/0/2/2	4
wb5414-03	Design of machines and mechanisms	2/2/0/0	3
wb1409	Theory of elasticity	2/2/0/0	4
wb1440	Eng.optimization: concept and applications	2/2/0/0	3
ct5142	Comp. methods in non-linear mechanics	0/4/0/0	3
wb1413-04	Multibody dynamics B	0/0/2/2	4
wb1310	Multibody dynamics A	0/0/0/2	3
wb1406-05	Experimental mechanics	0/0/2/2	4
wb1416	Computational engineering mechanics	0/0/2/2	3
wb1427-03	Advanced fluid mechanics A	2/2/0/0	5
wb1428	Computational fluid dynamics	0/0/2/2	3
wb1429-03	Microfluidics	0/0/2/2	3

Course code	Course name	Lecture hours	EC
wb1441	Engineering optimization 2	0/0/2/2	3
wb2306	The human controller	0/0/0/4	3
wb2402	Hydraulic servo systems	2/2/0/0	3
wb2413-04	Instrumentation	0/0/2/2	2
wb2414	Mechatronical design	2/2/0/0	3
wb2421	Multivariable control systems	0/0/4/0	6
wb2440	Modelling of dynamic systems	0/4/4/0	6
wi4008	Complex analysis		4
wi4011	Numerical fluid dynamics		6
wi4017	Non-linear differential equations		6
wm0605tu	Business economics for engineers		4
wi4070tu	Digital simulation A (+ 25 hours practical)	0/0/4/0	3
wm0621tu	Innovation management		3

1.8 Study and traineeship abroad

Study abroad offers a lot of attractive prospects. You become acquainted with a different (organisational) culture, different university life and a different educational system. Besides you enlarge 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 your first information on studying abroad it is recommended to visit the Back Office International Programmes of the Student Facility Centre. Much documentation about study abroad is available at this centre, like information on all universities with which an exchange agreement exists, possibilities for financing, and travel reports from students. Also information is available at the website: http://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 10EC 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 International Coordinator 3mE
Mw. M.P.I. Toppenberg
Room 8C, ground floor
Mekelweg 2
2628 CD Delft

Tel.: +31 15 278 6959
Fax.: +31 15 278 8340
E-mail: m.p.i.toppenberg@3me.tudelft.nl

1.9 Technical University Teacher Course (TULO)

Graduated Masters of Science in Biomedical Engineering have the opportunity to participate 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 EC 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.
Phone: 015 27 82786 / 015 27 83768
E-mail: j.geerlings@tbm.tudelft.nl

1.10 Enrolling for courses and tests

Usually it is necessary to enroll for courses and tests.

1.10.1 Courses

Students can enrol for specific courses at Blackboard (http://blackboard.icto.tudelft.nl). Most of the communication between lecturer and students goes by Blackboard announcements. Also exchange of information, assignments and reports often takes place via Blackboard.

1.10.2 Tests

Enrolling for tests is compulsory and can be done at the TAS-site ('Tentamen Aanmeld Systeem': http://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 using the campus card in a card reader. At the faculty there are two card readers: one is located near the Pallas/Parthemus computer room (4, 1st) and one is located at Education support staff (8B, 2nd floor).

1.11 Pass rules and criteria for 'cum laude'

1.11.1 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.

1.11.2 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.

1.11.3 'Cum laude'

At the discretion of the examinations board, 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 two and a half years;
c. the mark awarded for the thesis project shall be no less than 9;
d. the examiner of the graduation assignment shall have submitted a proposal for the award of "cum laude".

This is part of the "Regulations and guidelines for the board of examiners", Appendix 6.1 of this study guide.

1.12 Cheating, Citation and Plagiarism

When doing an assignment, project or other educational activity, the student uses sources and knowledge of other people. This is allowed if the following points are taken in mind:

Citation

Citation, literally copying text is allowed, if:
- The text is limited in length and
- The citation is made between quotation marks and
- The source, even when this is an internet source, is mentioned in a correct and complete manner.

Paraphrasing

Paraphrasing is defined as describing a text of a third party in your own words. This is allowed, if:
- It is mentioned what is being copied and of whom and
- The source, even when this is an internet source, is mentioned in a correct and complete manner and
- There is a clear separation between the ideas of the third party and own ideas.

Plagiarism

Plagiarism means copying of pieces of text, ideas, design and theories of others, without mentioning the source. Plagiarism is a form of cheating and is illegal.

Cheating

Cheating is wider than plagiarism and also includes taking a look at other's work during exams or refusing to make a proportional amount of effort in a group assignment, which is assessed based on the effort of the group as a whole. People, who do this, are called passengers.
Students suspected of copying, cheating, or being passengers, run the risk of being barred by the examination board from all tests and examinations held by TU Delft for up to one year. This can also have wide-ranging consequences for both the duration and the financial aspects of your course of study.
(With information from the TBM flyer 'Copying is a copout')

Organisation

2 Organisation

2.1 Interfaculty master programme

BioMedical Engineering is an interfaculty master programme. Three faculties collaborate in this programme: Faculty of Applied Sciences, Faculty of Electrical Engineering, Mathematics and Computer Science, and Faculty of Mechanical, Maritime and Materials Engineering. The administration of the BME-programme is held at the last mentioned Faculty. 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 in the first MSc year (LUMC and Erasmus MC), and in the tutoring of the MSc projects in the second year (LUMC, Erasmus MC, and AMC).

2.2 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 a yearly two-day symposium in 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.

2.3 Education support staff

The education support staff is executing the education support of the study Biomedical Engineering. For all issues related to the Biomedical Engineering study the students can get information.

Education Support Staff
Mekelweg 2, 2628 CD Delft
Location 8C, ground floor
Phone: 015 27 86959 / 015 27 83457
Fax: 015 27 88340

The Education Support Staff consists of the following persons:

prof.ir. Hans Klein Woud	Director of Education	j.kleinwoud@3me.tudelft.nl	Tel. 015 27 81556
ir. Nic-Jan van Bemmel	Manager Educational Programmes	n.j.vanbemmel@3me.tudelft.nl	Tel. 015 27 88791
Fatma Çinar	Education Administration office	f.s.cinar@3me.tudelft.nl	Tel. 015 27 86753
Teuni Eden	Student adviser	t.eden@3me.tudelft.nl	Tel. 015 27 82176
Lies Gesink	Education Administration office	e.g.gesink@3me.tudelft.nl	Tel. 015 27 86591
Louise Karreman	Study Administration office	l.m.karreman@3me.tudelft.nl	Tel. 015 27 83457
Ewoud van Luik	Coordinator Education	e.p.vanluik@3me.tudelft.nl	Tel. 015 27 85734
dr. ir. Dick Nijveldt	Educational Adviser & Coordinator international exchange	d.nijveldt@3me.tudelft.nl	Tel. 015 27 85921
Carel Piguillet	Software Support	c.f.f.piguillet@3me.tudelft.nl	Tel. 015 27 86820
Mascha Toppenberg	International MSc-coordinator	m.p.i.toppenberg@3me.tudelft.nl	Tel. 015 27 86959
ir. Jaap v.d. Zanden	Student adviser	j.vanderzanden@3me.tudelft.nl	Tel. 015 27 82996

2.4 Education committee

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

Chairman prof.dr. F.C.T. van der Helm
tel.: (015) 278 5616
e-mail: F.C.T.vanderHelm@3me.tudelft.nl

Secretary mw. D. Heersma
Mekelweg 2, kamer 8C-1-18,
2628 CD Delft
tel.: (015) 278 6400
e-mail: D.Heersma@3me.tudelft.nl

2.5 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 can be addressed to the board of examiners for participating in a deviating study programme.

Chairman prof.dr. F.C.T. van der Helm
tel.: (015) 278 5616
e-mail: F.C.T.vanderHelm@3me.tudelft.nl

Secretary E.P. van Luik
room 8C, ground floor
Mekelweg 2
2628 CD Delft
phone: 015 27 85734
e-mail: e.p.vanluik@3me.tudelft.nl

2.6 Student association

The master programme has an active student association "Friends of BME". This association organises meetings, break-out sessions, and other social events on a regular basis.

2.7 Student guidance

For assistance and advise to students the faculty has two student advisers. The student adviser is the person for questions or problems related to the study or about issues, which may influence the ability to study. The student adviser functions as oracle (vraagbaak) and as confidential consultant to students.

Individual help and advice
The student adviser has no educational responsibilities and can, therefore, devote himself totally to individual students and to help solving their problems which may be an obstacle to their study progress. He also takes seat in a lot of boards and has contact with the lecturers, so that he has up to date information about what is going on in the study Biomedical Engineering. He also has contact with other student advisers and personal advisers at the TU Delft and outside the University; so he knows what is going on elsewhere.

Personal circumstances
During a talk with a student adviser, often intimate information comes up. The student can be sure that this information will be dealt with confidentially. This kind of information will only be used after consultation with the student, to plead to apply TU- or faculty regulations.

Advice to Examination Committee
A student adviser can decide, as result of certain conditions, to advise e.g. the board of examiners, in favour of a specific student. When necessary the student adviser becomes an intermediary between TU Delft personal advisers: student, deans, psychologists and

physicians. The amount, in which the student adviser pays attention to a student, is up to the student. The student adviser keeps an eye on the study progress of most of the students and calls up one when necessary, but it is strongly recommended to contact the student adviser yourself when a question or problem comes up. Waiting often results in an increase of the problem. The two student advisers at the faculty are available for all 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 their study suffers delay due to special circumstances like physical illness, physical or sensory disorder, mental problems, insufficient organisation of the educational programme by the faculty.

Mrs. Teunie Eden, student adviser for all students BSc-MSc WbMT, as well as counsellor in case of harassment (see down this page)
Specialisms: Exchange students, International MSc-students, social programme international students.
Mekelweg 2, 8C, ground floor
Email: t.eden@3me.tudelft.nl
Phone: 015 27 82176

Ir. Jaap v.d. Zanden, student adviser for all students BSc-MSc 3me.
Specialisms: Graduate students, polytechnic high school students, quality control, student mentors.
Mekelweg 2, 8C, ground floor
Email: j.vanderzanden@3me.tudelft.nl
Phone: 015 27 82996

Dyslexia
Students having dyslexia usually have problems with reading and understanding of long texts. This can be an obstacle to 'normal' study progress. Therefore these students are advised to contact one of the student advisers and to set up a remedial plan. Important issues are:

- A planned study delay often helps
- When necessary, longer time for tests is possible
- Studying with a fellow student often results in more study progress
- IBG has extra student grants

2.8 Working conditions, RSI and harassment

RSI (Repetitive Strain Injury) is a well known problem by now. Within the TU Delft the number of complaints caused by RSI is increasing. Still too many employees and students neglect the first symptoms of RSI, without knowing where to go with their questions and

complaints. On the internet there is a lot of information to be found on this matter. An example is http://www.rsi.pagina.nl.
Free software, can be downloaded on the WbMT website, that helps you to prevent RSI: http://www.wbmt.tudelft.nl, button: "facilities".

Causes There are two mechanisms that cause RSI:

- Dynamic loading: repetitive dynamic loading 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.
- Static loading: constant stressing of muscles in the neck, shoulders and arms prevents blood circulation and squeezes off nerves. This results in cold and tingling fingers. Mental stress and unfavourable positioning of the body increases this effect.

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

Prevention How to prevent RSI:

- Vary repetitive tasks, like typing and using a mouse, with non-repetitive tasks, like walking to the printer or reading documents.
- Take regular breaks. It is recommended for every two hours work to take a 10-minute break and for every 10 minutes work to take a 20-second break, to improve blood circulation. It is even better to do exercises, within these breaks. For this purpose anti-RSI-software can help.
- It is strongly recommended to do no more than six hours of computer work a day.
- Make sure that the working position of the body is correct. A good installed workplace is important for a correct working position. 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.

Don't neglect the symptoms of RSI. For questions you can contact the following people:

- Student adviser
- Labour and environmental adviser Leen Paauw, l.paauw@3me.tudelft.nl
- Student Health Care (SGZ), tel: 015 2121507, studentenartsen@sgz.nl
- Student Facility Centre (SFC), http://www.sfc.tudelft.nl
- VSSD support, tel: 015 27 82057, http://www.vssd.nl

Harassment

Harassment is inappropriate, unwanted behaviour which disturbs someone. Teasing, mocking, gossiping, bullying, sexual or racial intimidation, violence and discrimination are all forms of harassment.

Counsellor

If you have problems you can turn to the Counsellor as appointed by each department within the university. Counsellors operate under strictly confidential and trustworthy conditions 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 DUT Complaints Committee. All actions are subject to your permission and approval.

If you experience any problems do not hesitate! Everyone at TU Delft has a right to feel respected and safe!

The Counsellor for our department is:
Mrs. T.Eden
Mekelweg 2, 8B 2th floor, room 28B
email: vertrouwenspersoon@3me.tudelft.nl
Phone: 015 27 82176

2.9 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 education director advises the dean.

Internal Quality Control:

Course Evaluation

- To evaluate the opinion of the students a "**course-evaluation-system**" exists. This system gives all students the opportunity to give their opinion on the education. The study programme and courses are evaluated each year by means of a questionaire.
- **Evaluation meetings** with students and lecturers.

Complaints

- Submitting and dealing with **complaints**. These complaints can be lodged at the students association or at the education director.
- The faculty evaluates itself regularly in a self-assessment.
- The student association establishes "Lecture Response Groups". These groups publish, together with lecturers, in the 'Meer dan Konsumentengids' their comments on the courses. They also give direct feedback to lecturers.

External quality control:

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

2.10 Information services

Study guide

This study guide is the main information source of the study programme and is available to all students at the education support desk (8B, 2th).

Blackboard

The website, however always contains the most recent information. Announcements, which are of importance for the study, like changes in the schedules, are made timely on the homepage of the faculty and at Black Board.

Grades

Schedules about the lectures, assignments and examinations are available at the desk of the study administration. At the homepage of the faculty and Black Board the changes in these schedules are given. Grades can also be found on blackboard.

Information that is not related directly to the study e.g. information by students association 'Leeghwater', will be published on publication boards. Members of 'Leeghwater' will be kept informed by e-mail.

2.11 Rules and Regulations

Student Statute (Studentenstatuut)

The Education Specific Part of the Student Statute (OSDS) applies to the education and the examinations of the study Biomedical Engineering.

The OSDS defines which educational services are given by the faculty and what is demanded from the students. The OSDS intends to offer the students an easy way to accomplish improvements in the educational situation, with help of the education director.

The OSDS consists of:

- This Study Guide.
- The Course and Examination Regulations for the study Biomedical Engineering (CER, see appendix 6.1).
- Implementation Procedures (appendix 6.2).
- Regulations and guidelines for the board of examiners (appendix 6.3).

Faculty regulations

- It is not allowed to smoke within the faculty building.
- Students have to follow the instructions given by staff members. Staff members are those who support or give lectures and those who are responsible for buildings and the surrounding areas.
- On the first demand of a staff member the student should identify him- or herself by showing the campus card.
- The student should be present in time, before the start of a lecture, assignment, instruction or meeting. The lecturer or assistant may reject 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

- Bikes should be placed in the bike stands provided.
- There is an opportunity to store personal belongings in lockers which are provided in the main hall. In the corridor situated next to lecture rooms A to F, bigger lockers can be used to store helmets. At the end of the study year, before the 15th of July, the lockers should be empty and the keys should be returned. Lockers, still in use after the 15th of July, will be provided with a new lock at the cost of the student.
- Eating and drinking is only allowed in the canteen, the coffee corner and in the immediate surroundings of a soda, candy, coffee or soup dispensers.
- Writing on, drawing on, sticking things on or scratching in furniture, walls, doors or windows is prohibited.
- Garbage and paper should be disposed of in bins.
- For the use of computers, network connections, printers and plotters there are rules and regulations, which should be taken in consideration.
- Disobeying of rules and regulations can result in a suspension or a denial of certain facilities. Theft or destruction on purpose of properties of DUT and also serious misbehaviour will be mentioned to the proper authorities.

Internet facilities

The utilisation of internet facilities at the faculty is bound to some regulations:

It is allowed to:

- Send e-mail to persons (or applications) from which can be expected that they will not consider the e-mail as annoying. Also you can receive e-mails which can be temporary stored in the inbox.
- Read online magazines and to place articles in it.
- Use the network information services like WWW-servers and FTP-servers, which are in use at this moment and also which will become available in the future. All use of services is bounded by regulations.
- Use the "Intranet DUNeT" on telephones provided through the faculty.

It is not allowed to:

- Damage or disable facilities.
- Use available facilities in any other way than they were supposed to be used:
  - Download, upload and fileshare of copyright protected items, such as texts, audio and video files, in any format.
  - 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 available facilities (including fellow students).
- Do damage or obstruct other users or equipment linked to the world wide web.
- Disrespect other peoples 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 the students.
- Distribute or show material that can be regarded as offending, for example insulting phrases or pornographic images or movies.

Sanctions:

- Account deactivation immediately after a violation has occurred.
- In case of serious violation and in case of repeated violation: prohibition of the use of ICT facilities, up to a year.
- In case of law violation: notification to the police.
- All claims, as a result of violations, are passed to the violator.

Facilities

3 Facilities

3.1 Lecture Rooms / Meeting Rooms

Lecture and meeting rooms of the 3 participating faculties are used.

3.2 Individual study facilities

At several locations in the faculty individual study places are available. Some of these study places are equipped with computers. These places are free to use, without reservation. Places should be left clean and tidy.
Besides the study places as mentioned above, there are also places to study in the central library (see 3.5). In the library students have to be silent. The same rules apply as for the study places.

3.2 Research facilities

The colloborating research groups in Biomedical Engineering (see Section 1.5.2) have many research laboratories to offer. Students may perform a part of their study, e.g. the MSc Thesis or a laboratory exercise in these laboratories. The laboratories are used for research activities of PhD students and staff.

3.3 Library

Central library

Prometheusplein 1
Postbus 98
2600 MG Delft
tel: 015 27 85678

The library of the TU Delft consists of a main building and smaller faculty libraries . The main building has a large collection of books and magazines. The main part of the collection can be borrowed from the library and has to be requested. 30 minutes after requesting the item will be available. The remaining part of the collection (open shelves) is only available within the library.

fax: 015 27 85706
www.library.tudelft.nl

The main building has more than 1000 study places (at the ground floor, on the different floors of 'the cone' and in a couple of group rooms), a computer room and coffee and candy dispensers.
To borrow a book, a student needs a library card, which pass can be acquired at the desk in the main building or at the faculty libraries.

		Lecture period	Exam period	Summer holiday
Opening hours	Mo - Thu	9:00 - 22:00	9:00 - 24:00	9:00 - 17:00
	Fri	9:00 - 18:00	9:00 - 22:00	9:00 - 17:00
	Sa and Su	10:00 - 18:00	10:00 - 22:00	Closed
Book desk	Mo - Thu	9:00 - 19:00	9:00 - 19:00	9:00 - 19:00
	Fri	9:00 - 17:00	9:00 - 17:00	9:00 - 17:00
	Sa	10:00 - 13:00	10:00 - 13:00	10:00 - 13:00

Books can be borrowed for a period of 28 days. This term can be extended as long as no other person makes a reservation for the book. As a maximum, 20 items can be loaned. If a book is requested but not available, the requester will receive a notification by email or post if the book is available.
The central library is behind the auditorium (aula) at the Prometheusplein, see appendix 6.5.

Request Searching and requesting books is possible by the online catalogue at http://www.library.tudelft.nl. This catalogue includes all collections of all libraries of the TU Delft. Besides the catalogue, requesting of books is possible at the desk of the central library and the faculty library.

Library card In order to use the library facilities a student is supposed to have a library card. This card can be requested at the desk of the central library or faculty library. To make the request the student must bring Personal Identification (passport, driver's licence, etc.) and an Address Identification (recent bank statement, insurance policy, etc.). The library card is free of charge and for personal use only.

3.4 Mailbox and access to the internet

Each student has the possibility to acces and communicate on the Internet. Therefore each student receives a faculty login account and an e-mail account. The email account is accessible everywhere, via a webmail server. At the faculty students can use printers, plotters, scanners, etc.

Printing Printing is paid for by a print account. Each student gets a welcome account of €11.50 to start with. At the reception desk the account can be upgraded, from 8:30 till 16:30.

It is possible to check the print account at all time, by pointing with the mouse on the 'dollar sign'-symbol in the taskbar at any computer at the faculty.

The services mentioned above are taken care of by:

I&A Service information and automation (Dienst Informatisering en Automatisering) (I&A):
Managing of computers, servers and the network.
Phone: 015 27 82001
E-mail: helpdesk@3me.tudelft.nl

System administrator and postmaster J.M.Kalkman, phone: 015 27 86858, e-mail: j.m.kalkman@3me.tudelft.nl, room 8A-1-06

DTO Service Technical Support (Dienst Technische Ondersteuning) (DTO):
Supporting when problems with accounts occur.
Phone: 015 27 82000
E-mail: info@dto.tudelft.nl

Service for Students

4 DUT - Services for students

Delft University of Technology (DUT) provides several service centres for students:
- Student Facility Centre
- Sports Centre
- Cultural Centre 'Mekelweg 10'
- Library

For all other services: refer to the DUT website, http://www.tudelft.nl.

SFC

The Student Facilities Centre (SFC) consists of several departments, which provide a diversity of services to students, staff members and faculties.

Some examples of these services are provision of information concerning:
- Studying abroad
- All possible forms of education at DUT
- Study support and advise
- Housing
- Financial support and sponsoring for students and student associations

Student Facilities Centre Front Office
Julianalaan 134
2628 BL Delft
Postbus 5
2600 AA Delft
Phone: 015 27 88012
http://www.sfc.tudelft.nl

Sports Centre

The Sports Centre provides all kinds of sports activities:
- Indoors, in several halls and gyms, in which almost any kind of sport can be done.
- Courses and trainings organized by professional instructors.
- Outdoors there are 12 tennis courts and (natural) grass fields for playing soccer, hockey, cricket, rugby, baseball and softball. Most of these fields are illuminated during evenings.

It is possible to use the facilities on an individual basis.

Sports Centre
Mekelweg 8
2628 CD Delft
Phone: 015 27 82443
Fax: 015 27 87087
http://www.sc.tudelft.nl

Cultural Centre 'Mekelweg 10'

Anyone who would like to express him/her self in an artistic manner can do this is at the CulturalCentre. The activities and courses are aimed at cultural education and at stimulating forms of expression such as: (audio-)visual, communicative, musical and dancing. 'Mekelweg 10' also supports cultural activities of student organisations and members of DUT staff.

The facilities are:
- Design studios
- Several studios for midi and Deejay's
- Darkroom for photography
- Video editing room
- Rehearsal room for musicians

Cultural Centre 'Mekelweg 10'
Mekelweg 10
2628 CM Delft
Phone: 015 27 83988
Fax: 015 27 83946
http://www.cc.tudelft.nl

ICT Infrastructure

Infrastructure services, concerning telephony and ICT facilities are provided by DTO (Technical Support Service). Services concerning students, as described at http://www.dto.tudelft.nl are:

- Internet facilities for student accommodation:
  A number of internet acces facilities for student accommodation are offered by the TU Delft.

- OLI:
  OLI is a foundation that supports students, by offering internet facilities, e.g. to support websites. This is possible for all kind of student organisations, like student associations, study associations, student's houses, etc.
  http://www.oli.tudelft.nl

Course descriptions

In general courses are given in English:

- **E:** means that the course is given in english
- **ER:** means that the course is given in Dutch, on request the course is given in English

For complete course descriptions see website, campus.3me.tudelft.nl.

ap3121d	**Imaging systems**
Lecturer	J.J.M. Braat
Course Material	Course notes "Imaging Systems"
Description	Basic properties of imaging systems, impulse response, frequency domain analysis. Source and illumination system; effects of coherence. Scanning systems. Distributed systems (apertue synthesis). Noise sources. Inverse problem in imaging. Examples of imaging systems from optics, acoustics and particle optics.
Education	Lecture **EC** 6
Assessment	Written exam

ap3351	**Radiation technology and radiation detection**
Lecturer	A.J.J. Bos, C.W.E. van Eijk
Course Material	G.F.Knoll, Radiation Detection and Measurement, John Wiley & Sons, 1989; W.R.Leo, Techniques for Nuclear and Particle Physics Experiments, Springer Verlag, 1987
Description	This course provides students an introduction to the application of radiation in medical, industrial and physics information technology. Radiation types, each with their specific properties, are introduced. Radiation sources like simple radioactive sources, particle accelerators, synchrotrons and X-ray machines are discussed. The interaction of radiation with matter is treated from the imaging point of view (transmission) as well as from the detection point of view (absorption). Radiation detection is an important subject in the course. Instrumentation for radiation detection is the main issue of this course.
Education	Lecture **EC** 6
Assessment	Written exam

ap3361	**Medical physics and radiation technology**
Lecturer	C.W.E. van Eijk, J. Zoetelief, A.J.J. Bos
Course Material	G.F.Knoll, Radiation Detection and Measurement, John Wiley & Sons, 1989
Description	The course is about selected topics concerning the detection of ionizing radiation, for instance i) the interaction of ionizing radiation with matter, ii) operation principles of several radiation detectors, iii) spectroscopic measuring techniques and data handling.
Education	Lecture **EC** 6
Assessment	Oral

ap3371	Radiological health physics (+31 hours pract.)	
Lecturer	A.J.J. Bos	
Course Material		
Description	Interaction between radiation and matter. Dosemetry. Biological working. Internal contamination. Measurement-methods. Masking. Safetymeasures. Rules and legislation	
Education	Lecture, exercises, pract.	**EC** 6
Assessment		

ap3471p	Measurement in images	
Lecturer	C.L. Luengo Hendriks	
Course Material	Hoeksma, Instruction Image Processing, Internal document of the Pattern Recognition Group. Gonzalez and Wintz, Digital Image Processing, Addison-Wesley,Reading MA	
Description	Introduction to measurement in images (image analysis). Exercises in different image processing operations. Solving simple problems.	
Education	Practical work 40 hours	**EC** 1.5
Assessment		

ap3531	Acoustical imaging	
Lecturer	C.P.A. Wapenaar, D.J. Verschuur	
Course Material	A.J. Berkhout, Seismic Migration, Elsevier, 1982;C.P.A. Wapenaar and A.J. Berkhout, Elastic Wavefield Extrapolation, Elsevier, 1989	
Description	Wave field decomposition (acoustic and elastic). Inverse wave field extrapolation (acoustic and elastic). Imaging principle. Acoustic and elastic Kirchhoff integrals. Applications in seismic exploration, medical imaging and non-destructive testing of construction materials	
Education	Lecture	**EC** 6
Assessment	Oral	

ct5142	Comp. methods in non-linear mechanics
Lecturer	Dr.ir. L.J. Sluys
Course Material	
Description	Recapitulatie van wiskundige gereedschappen die nodig zijn voor modelbeschrijving notatie; recapitulatie spannings- en rektensor en virtuele arbeid geometrische niet-lineariteit; staakwerkmodellen, stabiliteit, lineaire knikberekeningen oplossingstechnieken voor niet-lineaire statische problemen; verplaatsings- en krachtgestuurde methoden; Newton-Raphsonmethode; booglengtesturing; toepassing op eenvoudige systemen fysische niet-lineariteit; plasticiteit voor staal, beton en grond; scheurvorming in beton; lokalisatie en insnoeringsverschijnselen in staal en beton
Education	Lecture + exercise **EC** 3
Assessment	Oral exam

et4004	EM radiation, scattering and imaging
Lecturer	Dr. N.V. Budko
Course Material	
Description	Three basic electromagnetic processes are considered, namely: radiation from arbitrary current-distributions; scattering of given incident fields by arbitrary inhomogeneous objects; objects image formation from the measured scattered field. Fundamental three-dimensional equations in frequency and time domains are derived. Examples and computer simulations include: radiation from electric and magnetic dipoles, Born scattering from weak inhomogeneities, and linearized imaging by backpropagation.
Education	Lecture **EC** 3
Assessment	

et4083	Statistic signal processing
Lecturer	Prof.dr.ir. J. Biemond, Prof.dr.ir. R.L. Lagendijk
Course Material	R.L. Lagendijk and J. Biemond. Statistische Signaalverwerking. DUM, 1999. Reader (in English)
Description	After studying the course, the student has easy entrance to the vast amount of literature on this topic; he/she is able to develop algorithms for signal detection and estimation; he/she will gain a thorough understanding of the role of statistics/probability theory in signal processing.
Education	Lecture **EC** 3
Assessment	

et4085	Image processing
Lecturer Course Material	Dr. E.A. Hendriks / Prof.dr.ir. L.J. van Vliet
Description	image restoration (inverse filtering, Wiener filtering, geometric transformation), advanced morphological image processing and extension to grey-scale images, image segmentation (boundary detection, region-based segmentation, watersheds), representation and description of image objects, image features (structure tensor, local shape, Hough transform), camera calibration (intrinsic and extrinsic parameters, projection matrix), stereopsis (correspondence, epipolar geometry, essential and fundamental matrix), motion estimation (optical flow, feature-based techniques).
Education Assessment	**EC** 4

et4102	Mechatronic design
Lecturer Course Material	Dr.ir. J.B. Klaassens
Description	Mechatronic Design; An introduction Elementary principles of mechanics. Physical Modeling. Actuators: DC motor, Permanent magnet motor, stepper motor. Piezo actuator. Force control. Sensors for mechatronic applications. Hydraulic amplifier. X-by-wire.http://www.dcsc.tudelft.nl/~sc4100
Education	Lecture **EC** 2
Assessment	Written exam

et4126	Medical technology
Lecturer Course Material	Dr.ir. J.J. Gerbrands / Dr.ir. Th.J.C. Faes
Description	The use of medical technology in clinical practice (cycle of diagnosis and therapy). Physicla theory and engineering principles as basis for medical technology. Modelling and simulation of physiological processes in the human body. Measurement errors, quality and effectiveness of instruments. Safety and disinfection of instruments. These topics will be discussed for examples of diagnostic and therapeutic instruments.
Education Assessment	**EC** 4

et4127	Theme course biomedical technology
Lecturer Course Material	Dr.ir. J.J. Gerbrands / Dr.ir. Th.J.C. Faes / Dr.ir. W.A. van Duijl
Description	Every year another theme in biomedical engineering is presented. The subject and details of the course will be timely announced on Black Board of the university and on the website of Biomedical Engineering: (http://bmt.ewi.tudelft.nl). Each theme will be teached as an integration of physiological, clinical and technical disciplines.
Education Assessment	**EC** 4

et4129	Physical measurement methods & image techn.
Lecturer Course Material	Dr.ir. J.J. Gerbrands / Dr.ir. Th.J.C. Faes / prof.dr. R.M. Heethaar
Description	Imaging techniques in medicine (Microscopy, X-ray, CT, Echography, Scintigraphy, PET, MRI, Impedance tomography, MEG).
Education Assessment	**EC** 3

et4130	Bio-electricity
Lecturer Course Material	Dr.ir. J.J. Gerbrands / Dr.ir. Th.J.C. Faes / Dr.ir. W.A. van Duijl
Description	Ion processes in cell membranes. Creation and propagation of action potentials and neuromagnetic activity. Modelling. Clinical measurement and interpretation of bioelectric and biomagnetic signals.
Education Assessment	**EC** 3

et4137	Fuzzy logic engineering applications
Lecturer	Prof.dr.ir. J. Hellendoorn, Prof.dr. R. Babuska MSc
Course Material	
Description	Fuzzy logic techniques can be applied in various engineering domains, mainly in fields where reasoning under uncertainty plays an important role. This course provides background in fuzzy set theory, fuzzy logic and related soft-computing techniques with applications in control, information and data processing, artificial intelligence and decision making. See also: http:/www.dcsc.tudelft.nl/~sc4150.
Education	Lecture **EC** 2
Assessment	Written exam

et4147	Signal processing for telecommunications
Lecturer	Prof.dr.ir. A.J. van der Veen / Dr.ir. G. Leus
Course Material	
Description	Signal processing model of the wireless channel, elementary beamforming concepts (spatial filtering), tools from linear algebra: QR, SVD, eigenvalue decompositions, projections. Elementary beamformers/receivers: the matched filter, the Wiener filter. Estimation of angles and delays using ESPRIT, adaptive space-time filters and the LMS algorithm, the Constant-Modulus algorithm. Application to CDMA systems.
Education	**EC** 4
Assessment	

et4161	Information theory
Lecturer	Dr. A. Hanjalic
Course Material	
Description	This couse explains the basic ideas of information theory and the correspondances between the elements of this theory and certain natural concepts of importance in a wide number of fields, such as transmission, storage, authoring and protection of data. On the basis of simple concepts from probabiliby calculus, models are developed for a discrete information source and a discrete communication channel. Further, the theoretical basics for developing source coding algorithms is provided, as well as the basics of optimal data transmission through a discrete communication channel.
Education	**EC** 4
Assessment	

et4235	Digital signal processing
Lecturer Course Material	Prof.dr.ir. P.M. Dewilde, Prof.dr. A.J. van der Veen, A.J.vanderVeen@ewi.tudelft.nl
Description	Techniques in Signal Processing are treated as they really occur in major applications, most notably in telecommunications and multimedia. The course provides for a link between algorithm in Signal Processing and their implementation. We follow a modern approach: we start out from well-chosen main applications and develop the theory needed to fulfill the demands. Our starting points in this course will be (1) coding and modulation techniques for digital subscriber lines, in particular OFDM, (2) estimation and coding of speech as used in GSM and (3) selective filtering as is done in most radio receivers.
Education	Lecture **EC** 2
Assessment	Oral

et4248	Introduction to micro electronics
Lecturer Course Material	Prof.dr. C.I.M. Beenakker / Prof.dr. P.J. French
Description	This introduction to microelectronics provides an over-view of the different challenges in het field of Micro-electronics, as reflected by the research areas of the groups that comprise the department of microelec-tronics. The course includes visits to the various labora-tories, a visit to the DIMES facility and an excursion to a chip foundry. ET4, 14 hours lectures, 14 hours exercises.
Education	**EC** 3
Assessment	

et4249	Semiconductor comp. and techn.
Lecturer Course Material	Swaaij, dr. R.A.C.M.M. van
Description	Some basic semiconductor components are discussed, like the p-n junction, the p-n diode, the bipolar transistor and the field-effect transistor. The characteristics of these devices are explained on the basis of physical properties of meterials and interfaces between these materials.
Education	**EC** 5
Assessment	

et4250	IC technology
Lecturer	Ir. A.J.G. Spiekerman/ Prof.dr.ir. P.M. Sarro
Course Material	
Description	After an introduction on fabrication of pure monocrystalline silicon and meterial properties the major process steps in the fabrication of integrated circuits are discussed. Including photolithography. The basic concepts of silicon micromachining are introduced to illustrate the potential of 3D microstructuring in the development of microsystems. Finally process yield, component reliability, assembly and testing are considered. ET4, course.
Education	**EC** 4
Assessment	

et4251	HF silicon technology
Lecturer	Prof.dr.ir. J.W. Slotboom, Prof.dr. J.N. Burghartz
Course Material	
Description	This course will deal with integration principles to provide an idea of possibilities and limitations of inte-grated transistors, passive components, and intercon-nects at very high frequencies. First, typical process modules will be illustrated; those modules are the buid-ling blocks of integrated devices. Then, complete inte-grated divice structures, composed of such building blocks, will be explained. The high-frequency figures-of-merit will next be revisited while including parasitics from device integration.
Education	Lecture **EC** 3
Assessment	

et4252	Analogue IC design
Lecturer	Prof.dr. J.R. Long
Course Material	
Description	Topics include: Review of analog design basics. Linear and non-linear analog building blocks: electronics switches, switched-capacitor circuits, oscillators, comparators, AGC and limiting circuits, wideband amplifier design. Circuits for modulation, demodulation and frequency conversion. Physical layout (e.g., device matching) for robust analog circuits and analog simulation issues. Design of voltage sources ranging from simple voltage dividers to high-performance bandgaps, and current source implementations from a single resistor to high-quality references based on negative-feedback structures. Quality aspects, such as accuracy, output noise and output impedance are treated within the context of power consumption requirements.
Education	Lecture **EC** 3
Assessment	Oral and design project

et4253	Nanoelectronics & micropower design
Lecturer	Dr. J. Hoekstra
Course Material	
Description	This course offers an introduction to nanoelectronics, a new and advanced topic in electronics. Nanotechnology promises new small electronic devices that might provide faster, more highly integrated circuits with extremely low power consumption. The quantum behavior of the metallic single-electron tunnel (SET) junction device in electronics, we shall after a brief introduction to the devices and the physics of the nanodevices concentrate on the modelling of the devices both by analytical techniques and by SPICE simulation.
Education	**EC** 4
Assessment	

et4256	Reliability engineering
Lecturer	Bossche, dr.ir. A.
Course Material	
Description	This course aims to provide the students with a thorough understanding of the reliability of systems and components. After the course the students should see reliability and safety as basic requirements that should receive attention throughout a product's complete lifecycle: specification, design, production, exploitation and disposal. The following subjects will be treated: Failure mechanisms in Electronics (overview), Life-Time Distributions, Data Analysis, Reliability Models, Reliability Prediction, Reliable Design Concepts, FMECA, Fault Tree Analysis.
Education	**EC** 4
Assessment	

et4257	Sensors
Lecturer	French, prof.dr. P.J.
Course Material	
Description	The course silicon sensors gives an overview of the most important principles related to sensors fabricated in integrated silicon technology. The sensors are divided into those for optical, mechanical, thermal, magnetic and chemical signals. A special topic in this course is that of CMOS image sensors. This part of the course will deal with the most important principles, possibilities and limitations of image sensors which are fabricated in a standard CMOS process. All different imaging aspect of the solid-state image sensors ranging from "photons in" till "digital numbers out" will be studied. Special attention will go to the combination of the imaging function with the analogue and digital circuitry on-chip.
Education	**EC** 4
Assessment	

et4258	Displays & actuators
Lecturer Course Material	Vdovin, dr. G. / French, prof.dr. P.J.
Description	This course gives an overview of the most important principles which are applied to modern displays and actuators. In addition, external computer memory and printers are considered. We all work with displays, whether they be for clocks, pc or information boards. The mechanisms to create the display make use of a wide range of principles including electrical, magnetic, chemical and mechanical. These will be considered and a large number of applications given. The actuators lectures give the range from large machines down to silicon micromachined device in the micron range.
Education Assessment	**EC** 4

et4260	Microsystems integration
Lecturer Course Material	Huijsing, prof.dr.ir. J.H.
Description	The course is intended to be a hands-on activity in which the student is confronted with typical aspects of measurement and instrumentation, especially as they relate to the realization of single chip systems. The course consists of four parts of which only three will be taught in a given year. In the first part the basic instrumentation issues associated with continuous and sampled-data signal processing will be discussed. The second part covers measurement techniques widely used in integrated circuit testing, such as the measurement of layer thickness and sheet resistivity. The third and fourth parts discuss components widely used in measurements systems viz. operational amplifiers and analog-to-digital converters respectively. The course consists of only 12 lecture hours. The emphasis is on individual projects that involve the analysis of a measurement problem or the design of a small measurement system.
Education Assessment	**EC** 4

et8016	Structured electronic design
Lecturer Course Material	Verhoeven, dr.ir. C.J.M. / Staveren, dr.ir. A. van
Description	This course focuses on a systematic approach to the design of analog electronic circuits. The methodology presented in the course is based on the concepts of hierarchy, otholonality and simple models applied to the design of negative-feedback amplifiers. It is shown that aspects such as ideal transfer; noise performance, distortion and bandwidth can be designed independently. Also, methods to preserve this independence even when it is not naturally present in the design are described. A systematic approach to biasing completes the discussion. Lectures are interactive and combined with hand-on exercises.
Education Assessment	**EC** 4

et8016	Electronic instrumentation 1	
Lecturer	Dr.ir. R.F. Wolffenbuttel	
Course Material		
Description	1. Designing measurement systems for electrical and non-electrical quantities. 2. Estimation of the detection limit in electrical and non-electrical measurements. 3. Applying circuit and system techniques for measuring in the presence of high-level interference signals.	
Education	Lecture	**EC** 3
Assessment	Homework, Projects, exam	

ide521	Computer visualisation	
Lecturer	Ir. D.P. Saakes	
Course Material		
Description	In short, the idea of this course is to learn to use the computer to assist you in material studies and presenting your designs. You will select an existing product, preferably one of a previous design course. Next you will build a computer graphics model of this product and use this model to do a material study. At the end of the course you will render the material study in a presentation and create a presentation of the product in a context (product placement).	
Education	Assignment + Lectures	**EC** 3
Assessment	Presentation + Portfolio	

ide534	Ergonomical aspects data processing systems	
Lecturer	Ir. A.P.O.S. Vermeeren	
Course Material		
Description	Products now increasingly feature chips, buttons and displays and complex functionality. This can present users of these products with problems unless the interface between product and user is ergonomically well designed. For the industrial designer this means acquiring new design techniques alongside the traditional ones. This subject introduces students to a range of techniques for designing interfaces for such products and deQuarterining functionality from the user's point of view.	
Education	Lectures + exercises	**EC** 2
Assessment	Based on exercises	

in4008/4009	Data visualization
Lecturer	Ir. F.H. Post
Course Material	
Description	Theory and general principles of data visualization are discussed, and illustrated by practical examples from many application areas. Thopics covered: models of the visualisation process; basic 3D computer graphics; 2D graphs and charts; generation, representation and processing of data; colour and the use of colour; volume visualization and medical applications; visualization of vector fields and flows; feature extraction, and virtual reality. Guest lectures will be given on various topics. IN4, lectures 0/0/4/0 + lab 56 hours.
Education	**EC** 5
Assessment	

in4085	Pattern recognition
Lecturer	Dr.ir. R.P.W. Duin, Dr.ir. M.J.T. Reinders, Dr.ir. D. de Ridder, Dr. D.M.J. Tax, Dr. L.F.A. Wessels
Course Material	
Description	Recapitulation of Multi-dimensional statistics, data visualisation, density esimation, cluster analysis. Representation of real world objects by features, prototypes and dissimilarities. Training pattern classifiers by examples. Feature extraction. Bayes' rule. Classification by statistical discriminants, neural networks, decision trees or support vector machines. Statistical learning theory. One-class classifiers. Combined appraoches. EM algorithm. Partially supervised learning. Evaluation procedures, cross validation. Overtraining, regularisation.
Education	Lecture **EC** 6
Assessment	

sc4110	System identification B
Lecturer	prof. dr. ir. P.M.J. Van den Hof and dr. ir. X.J.A. Bombois
Course Material	Lecture Notes: P.M.J. Van den Hof, "System Identification" (1998). (in English).
Description	Experimental modelling of dynamical systems; methodology. Discrete-time signals and system analysis. Identification of transfer functions. Representations of linear models; black-box models; parametrised model sets. Identification by prediction error minimization; least squares methods. Approximate modelling; algorithms. Experiment design and data analysis; model validation. MATLAB toolbox.
Education	Lecture **EC** 5
Assessment	Oral exam

wb1310	Multibody dynamics A
Lecturer	Dr.Ir. Arend L. Schwab
Course Material	Lecture Notes and M.Wisse, Introduction to ADAMS, Delft, 1999.
Description	Multibody Dynamics id about the analysis of the motion of complex mechanical systems as in a robot arm, a railway bogie or a gantry crane. In this course you will learn about the fundamentals of Multibody Dynamics: the description of the orientation of a rigid body in space, the Newton-Euler equations of motion for a 3D rigid body, how to add constraints to the equations of motion, and how to solve such a system of coupled equations. Next you will spend most of the time (80%) in doing the assignments with the ADAMS Software.
Education	Lecture **EC** 3
Assessment	Written+Lab Report

wb1406-05	Experimental mechanics
Lecturer	Booij, J., M.Sc. and Woerkom, dr.ir. P.Th.L.M. van
Course Material	Course notes for Part A Course notes for Part B
Description	Measurement of static strains and shape changes in structures using strain gages, photo-elastic method, thermo-elasticity, raster techniques, Moiré, holography, and laser-speckle techniques. Measurement of structural dynamics: properties of materials, viscous damping and structural damping, visco-elastic materials, modal analysis, frequency response, modal parameter identification, identification of frequency transfer functions.
Education	Lecture **EC** 4
Assessment	Written report

wb1409	Theory of elasticity
Lecturer	Keulen, prof.dr.ir. A.
Course Material	Y.C. Fung, Foundations of Solid Mechanics,
Description	Stress and strain tensors, elastic constitutive equations, linear theory of elasticity, energy principles, energy theorems, stress functions, composite theory, homogenization
Education	Lecture **EC** 3
Assessment	Exercises + oral exam

wb1413-04	Multibody dynamics B
Lecturer	Dr.Ir. Arend L. Schwab
Course Material	Arend L. Schwab, `Applied Multibody Dynamics', Delft, 2003
Description	Dynamics of Mechanical Systems, Multibody System Dynamics, Kinematics, Spatial Systems.
Education	Lecture **EC** 4
Assessment	Oral exam

wb1416	Computational engineering mechanics
Lecturer	Daniel J. Rixen
Course Material	Lecture notes (available through blackboard)
Description	
Education	Lecture **EC** 3
Assessment	Oral exam

wb1427-03	Advanced fluid mechanics A
Lecturer	Westerweel, prof.dr.ir. J.
Course Material	Lecture Notes "Stromingsleer Voortgezette Cursus A (wbmt 1422A)", (in Dutch) in downloadable PDF-format. Introduction to Fluid Dynamics by G.K. Batchelor.
Description	Fluid mechanics, Kinematics, Dynamics, Equations of motion, Continuity equation, Stress-Deformation rate relationship, Navier-Stokes equations, Potential theory, Boundary-layer theory, Stokes flow
Education	Lecture **EC** 5
Assessment	Written

wb1428	Computational fluid dynamics	
Lecturer	Boersma, dr.ir. B.J., Pourquie, dr.ir. M.J.B.M.	
Course Material	J.H. Ferziger and M. Peric, Computational methods for Fluid Dynamics, Springer Verlag.	
Description	finite volume method, convection-diffusion equation, stability of schemes, conservation laws for flow problems,steady flow, time-dependent flow, turbulence models, turbulent flow, boundary conditions.	
Education	Lecture	**EC** 3
Assessment	Thesis	

wb1429-03	Microfluidics	
Lecturer	Lindken, R., Westerweel, prof.dr.ir. J.	
Course Material	Fundamentals and Applications of Microfluidics, by Nguyen & Wereley (Artech House, 2002)	
Description	This course is an introduction to microfluidics. We start with a review of fluid mechanics theory and electrokinetics. We study the typical geometries found in microfluidic devices and discuss different methods for experimental flow characterization, i.e. microPIV. This is followed by a discussion of microfluidic devices for external and internal flow control, i.e. microvalves, micropumps and microflow sensors, and microfluidic devices for life sciences and chemistry. The course will also introduce the student to numerical methods for solving microfluidic flows.	
Education	Lecture + Lab. demonstrations	**EC** 3
Assessment	Written exam	

wb1440	Eng.optimization: concept and applications	
Lecturer	Keulen, prof.dr.ir. A. van	
Course Material	P.Y. Papalambros et al. Principles of Optimal Design: Modelling and Computation.	
Description	Formulation of optimization problems, typical characteristics of optimization problems, minimization without constraints, constrained minimization, simple optimization algorithms, discrete design variables, approximation concepts, sensitivity analysis.	
Education	Lecture + excercises	**EC** 3
Assessment		

wb1441	Engineering optimization 2
Lecturer	Keulen, prof.dr.ir. A. van
Course Material	R.T. Haftka and Z. Gürdal: Elements of Structural Optimization.
Description	The course is intended as a follow-up course to wb1441. However, the focus is more on the use of numerical models. Aspects that will be presented are: Optimization techniques, Sensitivity analysis, Coupling with simulation techniques, Multi-objective optimization, Multi-disciplinary optimization The course will be organized as a special topics course.
Education	Lecture + excercises **EC** 3
Assessment	

wb2301	System identification & parameter estimation
Lecturer	Van der Helm, Prof.dr. F.C.T.
Course Material	Dictaat Signaalanalyse, Van Lunteren / Dankelman (in Dutch) Dictaat Systeemidentification A, Overheads, Demonstration programs in Matlab
Description	Non-parametric system identification based on estimators of spectral densities. Application to open-loop and closed-loop systems. Parameter estimation for linear and non-linear systems.
Education	Lecture **EC** 7
Assessment	Oral exam on final written assignment

wb2303	Measurement techniques
Lecturer	Teerhuis, ir. P.C.
Course Material	
Description	Statical and dynamical performance of mechanical measurement systems. Motion and dimensional measurement devices. Force, torque, pressure and temperature measurement devices. Conditioning, transmission and manipulation of measurement data.
Education	Lecture **EC** 3
Assessment	Oral

wb2306	The Human Controller	
Lecturer	Helm, prof.dr. F.C.T. van der	
Course Material	Reader: Cybernetical ergonomics.	
Description	Cybernetical ergonomics, sensory organs, motoric system, fysical load, mental load, human operator control, supervisory control, ergonomic design.	
Education	Lecture	**EC** 3
Assessment	Written	

wb2308	Biomedical Engineering Design	
Lecturer	Plettenburg, dr. ir. D.H., Herder, dr.ir. J.L.	
Course Material	Reader: "Ontwerpen in de medische techniek" edited by Just L. Herder and Dick H. Plettenburg (partly in Dutch)	
Description	Medical systems design, Diagnosis; Treatments, Orthopaedics, Rehabilitation.	
Education	Lecture 4/0/0/0	**EC** 4
Assessment	conceptual engineering design project	

wb2309	Introduction specialisation MMS and BME	
Lecturer	Wieringa, prof.dr.ir. P.A. and others	
Course Material	A report describing the above topics and some general guidance will be available.	
Description	Introduction of the research field and section Man-Machine Systems, its mission and challenges, overview of the research projects, introduction of staff, course and study planning advices	
Education	Lecture	**EC** 1
Assessment	Presence is obligatory	

wb2402	Hydraulic servo systems
Lecturer	Teerhuis, ir. P.C.
Course Material	T.J.Viersma. Analysis synthesis and design of hydraulic servo systems and pipelines. Blackburn, Reethof and Shearer. Fluid power control. Wiley and Sons.
Description	Dynamic behaviour of hydraulic servo systems Design of (low function) servo systems Hydraustatic bearings, hydraulic line dynamics
Education	Lecture **EC** 3
Assessment	

wb2404	Man-machine systems
Lecturer	Wieringa, prof.dr.ir. P.A.
Course Material	Reader: Man-Machine Systems, Peter A. Wieringa (Blackboard)
Description	Human Operator Models, Operator Supervisory Control, Cognitive Modeling, Task Analsysis, Operator Support Systems, Human Error, Alarm Handling
Education	Lecture **EC** 4
Assessment	Oral exam

wb2407	Human movement control
Lecturer	Helm, prof. dr. F.C.T. van der
Course Material	Reader (in preparation): Human movement control. Scientific papers handed out during the course.
Description	Biomechanics, biophysics, biomedical engineering, human movement control, motion recording, robotics, musculoskeletal systems.
Education	Lecture **EC** 4
Assessment	Written

wb2408	Physiological systems
Lecturer	Dankelman, prof. dr. J., Grimbergen, prof.dr.ir. C.A.
Course Material	J. Dankelman, C.A. Grimbergen, J.A.E. Spaan. Fysiologische Systemen (Physiological Systems) lecture notes in Dutch and in English (under preparation).
Description	Functioning of physiological systems described from an engineering point of view. Subjects are heart, circulation, muscles, lungs, kidneys and nerve system. Modelling, measurement techniques, design of artifical organs
Education	Lecture **EC** 3
Assessment	Oral

wb2413-04	Instrumentation
Lecturer	Mainly from industry. Course organizer Weiden, dr.ir.A.J.J. van der
Course Material	Lecture notes
Description	Design process of a real chemical industrial plant. Process Control and Instumentation. Supply systems and secrurity issues. Distributed proces control and information mangement and alarm systems. Excursions to equipment suppliers, engineering offices and to real plants.
Education	Lecture + 2 excursions **EC** 2
Assessment	

wb2421	Multivariable control systems
Lecturer	Weiden, dr.ir. A.J.J. van der
Course Material	Multivariable Feedback Control Analysis and Design. S.Skogestad, I.Postlethwaite. Lecture notes: The poles and zeros of multivariable systems, A.J.J. van der Weiden.
Description	The lectures are divided into blocks. At first a review of elementary single-loop feedback design is given. In the second block of lectures a system theoretical approach is used to explain the properties and the computation of the poles and zeros of multivariable feedback systems. Furthermore internal stability and the generalized Nyquist stability is discussed. The third block treats performance and robustness of multivariable feedback systems. The use of principal gains (singular values) for assessing performance is introduced.
Education	Lecture **EC** 6
Assessment	Oral examination and excercises based on MATLAB.

wb2431	Bone mechanics and implants
Lecturer	Linden, mw. J. van der, Valstar, dr.ir. E.R.
Course Material	Notes handed out during course
Description	This lecture series will give an overview of the functioning of the human skeleton, its evolution, growth and degeneration and artificial prostheses which are frequently used when parts of the skeleton fail.
Education	Lecture **EC** 3
Assessment	Oral examination after appointment

wb2432	Bio Mechatronics
Lecturer	Helm, prof.dr.ir. F.C.T. van der, Plettenburg, dr. ir. D.H.
Course Material	A reader is available through Blackboard
Description	Biomechatronics is a contraction of biomechanics and mechatronics. In this course the function and coordination of the human motion apparatus is the central focus, and the design of assistive devices for the support of the function of the motion apparatus. Examples are assistive devices like an orthosis, prosthesis or Functional Electrical Stimulation of muscles. The goal is to provide some function to patients with functional deficiencies.
Education	Lecture 0/0/2/2 **EC** 4
Assessment	Written exam

wb2435-03	Surgical instruments and medical safety
Lecturer	Mw. prof. dr. J. Dankelman
Course Material	Lecture notes (in preparation)
Description	Introduction to surgery, dissect and connect tissue. Surgical instruments and their specific requirements. Quality of surgical tools, quality control, sterilization. Advances and disadvantages of minimally invasive surgery (keyhole operations). Possibilities and problems of using robotic systems during surgery. Task analysis of the surgical process. Training of surgeons, Pelvi- and VR-trainers, on-site training.Operation rooms, equipment. Safety issues in the operation room.
Education	Lecture **EC** 2
Assessment	Oral exam

wb2436-05	Bio-inspired Design
Lecturer	Dr.ir. P Breedveld, Dr.ir. J.L. Herder, Prof.dr. T. Tomiyama
Course Material	Handouts
Description	The course Bio-Inspired Design gives an overview of non-conventional mechanical approaches in nature and shows how this knowledge can lead to more creativity in mechanical design and to better (simpler, smaller, more robust) solutions than with conventional technology. The course discusses a large number of biological organisms with smart constructions, unusual mechanisms or clever processing methods and gives a number of technical examples of bio-inspired instruments and machines.
Education	tekst 0/0/4/0 **EC** 3
Assessment	Written report

wbp202	Haptics system design
Lecturer	J.L. Herder, R.Q. van der Linde
Course Material	Reader, Blackboard, Website: http://mms.tudelft.nl/staff/herder/haptics.htm
Description	Haptics, master-slave, control, manipulator, mechanical design, parallel mechanisms, psychophysics
Education	Assignment **EC** 4
Assessment	Written report

wi4008	Complex analysis
Lecturer	Prof.dr. H.G. Meijer
Course Material	
Description	Complex numbers. Analytic functions. Complex integration. Residue calculus. Zeros, poles, identify theorem, analytic continuation. Conformal mappings.
Education	**EC** 4
Assessment	

wi4011	Numerical fluid dynamics
Lecturer	Prof.dr.ir. P. Wesseling
Course Material	
Description	Basic equations of fluid dynamics. Numerical methods for convection-diffusion equations: finite volume schemes; stability, consistency and convergence of numerical schemes; Fourier stability analysis, local grid refinement; singular perturbation theory; uniform accuracy and efficiency for vanishing viscosity. Numerical solution of the time-dependent and time-independent incompressible Navier-Stokes equations. Pressure-correction method. Direct and iterative solution methods for large sparse systems. Distributive iteration methods for the Navier-Stokes equations. Remarks on programming in MATLAB. Numerical methods discussed for the convection-diffusion and Navier-Stokes equations have been implemented in MATLAB programs that are made available.
Education	**EC** 6
Assessment	

wi4014tu	Numerical analysis C2
Lecturer	Ir. J. J. I. M. van Kan
Course Material	J. van Kan en A. Segal, Numerieke methoden voor partiële differentiaalvergelijkingen. DUM, 1993
Description	Numerieke methoden voor partiële differentiaalvergelijkingen. Klassifikatie van PDV's, eindige differentie, volume- en elementenmethode. Minimaliseringsproblemen. Methoden van Ritz en Galerkin. Lineaire en hogere orde basisfuncties. Conforme en niet conforme elementen. Foutschattingen. Oplossen van grote ijle stelsels lineaire vergelijkingen. Toepassingen op warmtegeleiding, trillingen en transportproblemen
Education	Lecture **EC** 4
Assessment	4 take-home excercises and practical exercise of 30 hours

wi4070tu	Digital simulation A (+25 hours pract.)
Lecturer	Dr. S.A. Borovkova
Course Material	
Description	Digitale simulatie A versie. Modelbouw, Monte Carlo-methoden, simulatie en modelbouw met PROSIUM, satistische aspecten m.b.t. in- en uitvoer.
Education	**EC** 4
Assessment	

wm0605tu	Business economics for engineers	
Lecturer	drs T. Poot	
Course Material		
Description	After having completed this course successfully the business-economical principles will no longer pose a mystery. Profit / loss queries, financing businesses and projects, and accounting of business processes will all be treated. Business-economical basic principles will be actively applied. Special attention will be given to the business-economical situation of innovative businesses.	
Education	Lecture	**EC** 4.5
Assessment	Written exam	

wm0621tu	Innovation management	
Lecturer	Prof. dr. A.H. Kleinknecht	
Course Material	J. Tidd, J. Bessant & K. Pavitt: Managing Innovation, Chichester: J. Wiley & Sons, second edition, 2001, ISBN: 0-471-49615-4 (paperback)	
Description		
Education	lecture	**EC** 3
Assessment	Written exam	

wm1101tu	Upper-Intermediate english (refresher)	
Lecturer	mr. A.K. Chatterjee	
Course Material	Murphy, Raymond (1994, 2nd ed.). English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students, (with answers). Cambridge	
Description	The course is based on a series of texts relating to various topics. Students are required to study the texts in detail and their knowledge will be tested each week. Listening skills will be developed while oral communication skills will be improved through discussion and conversation, and writing skills through the regular assignments. Each week there will also be the opportunity to discuss and revise vocabulary and grammar arising from the texts studied. In the second half of the course each student will be required to give a short presentation, which will be followed by detailed individual feedback.	
Education	Lecture	**EC** 3
Assessment	Written exam, written assignments, oral presentation	

wm1102tu	Written english for technologists
Lecturer	drs. E. McDonagh
Course Material	Swales, John M. and Christine B. Feak (1994) Academic Writing for Graduate Students: A Course for Nonnative Speakers of English. Michigan: The University of Michigan Press
Description	This course is designed for students who are nearing the end of their studies in Delft and whose English is already of a reasonably high standard. As the name of the course suggests, the focus throughout will be on writing. Not only will your written English be corrected but you will also be taught how to structure essays, reports or theses. Attention will be paid to style and plenty of tips will be given on ways to improve and invigorate your writing. Your systematic mistakes will be pointed out so that you can become critical about your own writing while at the same time improving it.
Education	Lecture **EC** 3
Assessment	course attendance, assignments, report

wm1109tu	Scientific writing and oral presentation
Lecturer	drs. B.M.D. van der Laaken
Course Material	Robert A. Day, How to write and publish a scientific paper, 5th Edition, Cambridge University Press, 1998; Bob van der Laaken: Reader Presentation Skills WM0203.
Description	Reinforcing communicative skills in English. At the end of the course the student is able to write scientific texts (articles, Master's Thesis) and to give scientific oral presentations which meet the communicative and linguistic requirements of the scientific community.
Education	Lecture **EC** 3
Assessment	Article and Presentation

Humane biologie (code:BP031; 6 ECTS)

Programma: Biomedische wetenschappen
Docent(en): Prof.dr. R.E. Poelmann (LUMC)
Periode: 19 september – 14 oktober 2005

Hoofddoelstellingen

1. Het hebben van inzicht in de ruimtelijke bouw van het volwassen lichaam.
2. Het kunnen toepassen van ontwikkelingsbiologische principes die leiden tot het ontstaan van een (volwassen) organisme.
3. Principes van visualisatietechnieken kunnen toepassen ter verwerving van een driedimensionaal inzicht in de bouw van weefsels, organen en het gehele organisme.
4. De architectuur van met name het cardiovasculaire systeem kunnen relateren aan het biomechanisch functioneren van hart en vaten.

Samenvatting inhoud

Het blok richt zich op de bouw en het functioneren van het menselijk lichaam op een aantal organisatie niveaus: anatomie, celbiologie, circulatiefysiologie en embryologie. Het zal tevens een inleiding geven in een aantal observatietechnieken, die gebruikt worden om de ruimtelijke opbouw van het lichaam te bestuderen. Er wordt een algemene basis gelegd ten behoeve van het eerste studiejaar. Het (menselijk) lichaam wordt gevormd en onderhouden door een ingewikkeld samenspel van moleculen, cellen, weefsels en organen. Een belangrijk accent in het eerste jaar wordt gelegd op het niveau van moleculen en cellen. In dit blok wordt met name aandacht gegeven aan het niveau van weefsels en organen, maar ook aan het gehele organisme, zodat de student een goed begrip krijgt van het ontstaan, de bouw en het functioneren van het gehele lichaam.

Zenuwstelsel (code: M1822; 5 ECTS)

Programma: Geneeskunde
Docent(en): Dr. E.L.E.M. Bollen, blokcoördinator (LUMC)
Periode: 5 – 23 december 2005

Hoofddoelstellingen

Voorzover relevant voor het analyseren en begrijpen van ziekteprocessen kan de student de normale bouw en ligging alsmede het normale functioneren van het zenuwstelsel beschrijven.
De student kan het onderscheid tussen normaal en abnormaal functioneren van het zenuw-stelsel waarnemen en beredeneren.
De student kan een eenvoudig klinisch probleem oplossen, daarbij gebruik makend van bovenstaande inzichten.

Samenvatting inhoud

In dit blok komen op een geïntegreerde wijze de bouw en de functie van het zenuwstelsel aan de orde, en je oefent je in het observeren en herkennen van een gestoorde functie van het zenuwstelsel. Je leert de functiestoornissen te bewaken.
In practica leer je de driedimensionale structuur van de hersenen te herkennen aan de hand van tweedimensionale beelden die verkregen zijn met de moderne beeldvormende technieken van de geneeskunde.

1.6.2.1.3 Functional and Chemical Neuroanatomy (Code: BB050; 6 ECTS)

Opleiding: Biomedische wetenschappen
Docent(en): Dr. E.A.J.F. Lakke (LUMC)
Periode: 23 januari – 17 februari 2006
Voertaal: English

Hoofddoelstellingen

The student will be able to understand:
1. the morphology and function of the mature central nervous system.
2. the clinical approach to the central nervous system.

Samenvatting inhoud

The module Functional and Chemical Neuroanatomy deals with the construction and function of the nervous system. At the molecular level, attention is paid to the electrical cellular channel functions, action potentials and the mechanisms underlying neurotransmitter action. At the tissue level, the connections and networks of neurons are studied from two perspectives:
Hodological: what are the important tracts and what are their functions? The main topics are: sensibility, motor systems, cerebellum and striatum. Cortex and hippocampus are topics in the module Hormones and the Nervous System.
Neurobiological: Parkinson's disease.
The module is partially based on problem based learning, thereby using several computer programmes. The brain is studied macroscopically using gross anatomy and the computer program "Caput", while microscopy of the connections is studied with the aid of "Marani's mind-maker" and a microscopy computer program. The module continues with aspects of Neurology (sensibility, motor systems, striatum and cerebellum) and Neurosurgery (clinical decision making) as related clinical topics.

Internal Regulation I (code: BB290; 6 ECTS)

Programme: Biomedische wetenschappen
Teachers: Prof.dr. A. van der Laarse and Dr. L.J.S.M. Teppema (LUMC)
Period: 6 – 31 maart 2006

Aims

The student will be able to define the functions of the heart and lungs. relate their function to their specific anatomical, mechanical and (with regard to the heart) electrical properties. describe how the heart and lungs cooperate to supply sufficient oxygen to the tissues and to remove the metabolic end-product carbon dioxide from the body illustrate with clinical examples how pathophysiologic conditions of the cardiorespiratory system can be viewed from basic physiological principles

Summary

The course Internal Regulation I consists of two modules on the physiology of heart and lungs and on the interrelationships between these two organs. The module Heart will be focused on five major themes: 1) anatomy of the myocardium and the heart; 2) cardiac contraction (mechanical properties of the heart); 3) electrical activity of the heart cell (electrophysiological properties of the heart including electrocardiography); 4) inborn diseases that cause arrhythmias; and 5) cardiac pump function. The module Lungs will consist of three major themes: 1) anatomy of the respiratory system; 2) mechanics of breathing in health and disease; 3) physical and physical-chemical principles on which gas exchange in lungs and tissues, gas transport by the blood and pulmonary ventilation are based. Practicals will be held to illustrate these basic principles.

Tools of the Century 2: Medical Imaging Technology (code BB311; 4 ECTS)

Opleiding: Biomedische wetenschappen
Docent(en): Dr. J. Doornbos and Prof.dr. A. de Roos (LUMC)
Periode: 8 – 23 december 2005

Hoofddoelstellingen

The student will be able to:
1. discuss the general role of radiology in diagnosis and treatment;
2. comment on the medical aspects of imaging techniques (indications, contra-indications, specificity and sensitivity);
3. answer questions on the basic physics of imaging techniques.
4. discuss the possibilities and the limits of the techniques.
5. justify his/her preference for a specific technique on the basis of cost effectiveness.
6. comment on recent developments in radiology.

Samenvatting inhoud

This course focuses on key aspects of various radiology techniques for diagnosis, treatment and therapy monitoring. Since the discovery of X-rays 100 years ago, many more imaging techniques have been developed, such as ultrasound, gamma radiation, magnetic fields and radio frequency radiation. The physical background and clinical use of X-rays, ultrasound, Computed Tomography and Magnetic Resonance Imaging will be shown and discussed in demonstrations and case histories. The latest developments in radiology will be the topic of keynote lectures.

Houding en Beweging (Code: M2831; 4 ECTS)

Opleiding: Geneeskunde
Docent(en): Dr. Mr. A.C.G. Wenink (LUMC)
Periode: 13-31 maart 2006

Hoofddoelstellingen

Een volledige analyse van een klacht met betrekking tot het bewegingsapparaat vergt inzicht in bouw en functie van dat apparaat alsmede in enkele eenvoudige biomechanische principes en hun toepassing op de functie van gewrichten en van spiergroepen. Deze analyse komt daarom aan de orde.
Er wordt toegewerkt naar de toepassing van verworven (te verwerven) inzichten op ziekteverschijnselen bij patiënten. Je leert deze analyseren en vergelijken met beschrijvingen in een leerboek. Je leert omgaan met de besturing van gewrichten door spieren en spiergroepen en met de betekenis van de zwaartekracht daarbij. Daardoor wordt het mogelijk door bestudering van een gestoord bewegingspatroon aan te geven wat er fout is gegaan.

Relatie met andere blokken

Het blok bouwt voort op het blok Morfologie van de Mens (Gnk1), waarin algemene aspekten van het bewegingsapparaat aan de orde zijn gekomen, terwijl onderwerpen

uit het blok Zenuwstelsel (Gnk1), met name het perifere zenuwstelsel, bekend worden verondersteld. Het blok vormt een basis voor het direkt aansluitende blok Trauma (Gnk2), en het bereidt voor op het blok Bewegingsapparaat (Gnk3).

Samenvatting inhoud

Patiënten met aandoeningen van het bewegingsapparaat vormen één van de grootste groepen in de wachtkamer van de huisarts. De juiste benadering van deze patiënten vergt inzicht en vaardigheden op verschillende terreinen. In dit blok komen op geïntegreerde wijze de bouw en de functie van het bewegingsapparaat aan de orde. Op globaal niveau wordt de macroscopische bouw bestudeerd. Het inzicht blijft niet beperkt tot boekenwijsheid: in anatomische practica doe je zelfstandig waarnemingen omtrent deze bouw.
In dit blok is gekozen voor casusbeschrijvingen als basis.

Sturing en Regeling (Code: M1860)

Opleiding: Geneeskunde
Docent(en): Dr. R.J. van den Berg, blokcoördinator (LUMC)
Periode: 13 – 31 maart 2006

Hoofddoelstellingen

1. De student kan de basale principes van fysiologische regelkringen beschrijven en kan deze toepassen op regelsystemen die van belang zijn voor de handhaving van het milieu interieur en voor de voortplanting.
2. De student kan de macroscopische en microscopische bouw en ligging van de bij de regeling betrokken weefsels en organen beschrijven.
3. De student is in staat te beredeneren welke consequenties het abnormaal functioneren van een onderdeel van het regelsysteem heeft voor het systeem als geheel.
4. De student kan studieresultaten presenteren tijdens een voordracht voor een forum bestaande uit studenten en docenten.

Samenvatting inhoud

Het menselijk lichaam is een gecompliceerde structuur, bestaande uit cellen, weefsels en organen. Het functioneren van het lichaam berust op een fijn afgestemd samenspel van de verschillende onderdelen, die vaak een regelkring vormen. De communicatie in een regelkring vindt plaats door middel van boodschappen in de vorm van elektrische signalen, zoals actiepotentialen door neuronen, of in de vorm van chemische signalen, zoals hormonen door kliercellen. Sturing en regeling van uiteenlopende fysiologische grootheden zijn essentieel voor het overleven van het individu. Bij hormonale en neuronale regelingen vindt negatieve terugkoppeling of tegenkoppeling plaats, een mechanisme waarbij een verandering van de geregelde grootheid wordt teniet gedaan en dus constant blijft (homeostase). Tegenkoppeling leidt tot stabiele regeling van uiteenlopende fysiologische grootheden. Een defect in een onderdeel van de regelkring, bv. een hyper- of hypofunctie van het betrokken weefsel, kan een ernstige ziekte veroorzaken. Ter sprake zullen komen regeling en ontregeling van de lichaamstemperatuur, de schildklierhormoon- en bijnierhormoonconcentratie in het bloed en van de koolhydraat- en vetstofwisseling. Ook de regelsystemen die een rol spelen

bij de voorplanting, het overleven van de soort, zullen aan bod komen. De bouw van de bij de regeling betrokken weefsels zal op microscopisch anatomische wijze worden bestudeerd. In dit blok zal tevens aandacht worden besteed aan de vaardigheid om mondeling te presenteren.

Mesenchymal differentiation and pathology of bone

Opleiding: Geneeskunde
Docent: Prof. dr. Pancras C.W. Hogendoorn (LUMC)

Samenvatting:

The skeletal system acts in the human body as mechanical scaffold for movement and body shape, it is also essential in mineral homeostasis. Moreover the skeletal system houses important parts of the hematopoetic system. These functions are the result of a delicate interplay both during development and adult live of the different cells which develop and differentiate during embryology till the terminal differentiated forms which can easily be recognized in adult mature bone: osteoblasts, osteocytes, osteoclasts, chondrocytes. In a number of pathological processes either as a reaction to exogenous noxe or as a result of an intrinsic disease process there is a disturbance in this interplay resulting in metabolic abnormalities, growth abnormalities, or even neoplastic growth. Our knowledge and understanding of normal mesenchymal growth and differentiation vastly contributes to the understanding of these pathological processes.
During this theme we will study normal skeletal development and homeostasis, developmental abnormalities, such as congenital malformations and dwarfism, diseases associated with abnormal matrix production, such as osteogenesis imperfecta, diseases associated with abnormal mineral homeostasis, such as renal osteodystrophy, fracture healing and abnormal (neoplastic) growth, the latter resulting in diseases such as osteochondroma, chondroblastoma and chondrosarcoma.
In this week several case studies are performed. Via the learning of morphological changes in the affected body parts, both macroscopically as well as microscopically, we will study the origin of a number of fundamental mechanisms of bone differentiation and growth. The effects of disturbed regulation of physiological mechanisms - resulting in pathology - will be learned and the observed alterations in structure and function will be related to the patient's clinical symptoms and signs. In addition, relevant research themes, including molecular diagnostics, will be illustrated in optional science demonstrations. The progress in understanding disease from basic science results will be discussed in a journal club.

Kvr1	Histological techniques
Lecturer(s):	Dr. G.J. van Osch (g.vanosch@erasmusmc.nl) (Erasmus MC)
Description	Histological techniques include those techniques in which thin slices of the tissue under study are made to enable viewing under a microscope. Using these techniques, high resolution images of small parts of the tissue can be obtained. This is often the gold standard in evaluating tissues and differentiating between normal and diseased tissues in a research setting, or for diagnosis. This module will teach the different steps needed to obtain a high quality microscopic image and involves techniques such as: tissue preparation, fixation methods, staining methods, use of antibodies, molecular methods, fluorescent microscopy and quantification methods. The course will focus on health and disease of tissues of the skeletal/cardiovascular system. The module will be finished with a practical training session in which the students will prepare histological sections and evaluate those under supervision of scientists and pathologists with experience in this field.
Education	self study, practical training and assignment
Assessment:	report and oral exam (EC1)

Kvr2	CT imaging in research and in the clinic
Lecturer(s):	dr. F. Cademartiri / prof. dr. ir. Weinans (h.weinans@erasmusmc.nl) (Erasmus MC)
Description	Computed Tomograpy (CT) imaging is an essential method for three dimensional imaging of tissues. This technique is frequently used both clinically and in research. In computed tomography methods, a series of projection images of a patient or specimen taken from different angles is used to create a three dimensional 'image' of the tissue. This course will show the use of this technique in a clinical and animal experimental setting: CT scans are used e.g. to detect diseases and track changes in the bone architecture in experiments. The subjects dealt with will cover the essential physics, reconstruction algorithms and various methodological issues such as beam hardening, reconstruction artifacts and noise. A variety of applications will be presented and quantitative analyses methods essential for a correct interpretation of the scans will be explained. During the practical training the students will work with a micro-CT scanner and perform a variety of scans on in-vitro specimens.
Education	self study, practical training and assignment
Assessment	report and oral exam (EC1)

Kvr3	Echography (use of Ultrasound imaging in diagnostic procedures)
Lecturer(s):	prof. dr. ir. A.F.W. van der Steen / prof. dr. ir. N. de Jong (Erasmus MC)
Description:	Echocardiography is after the Electrocardiogram the most commonly used diagnostic technique in Cardiology. Also in other areas like Obstetrics, Gynecology and Radiology it is commonly used. This course will be a hands-on teaching course of echography. First the elementary functions of components of echo equipment will be taught. Then elementary echo equipment will be built and in vitro measurements performed. The functionality of clinical echo equipment will be evaluated in the laboratory by applying it to volunteers. These include standard B-mode imaging, motion imaging with high temporal resolution, flow-imaging using Doppler techniques and 3D echocardiography. Finally the applied skills can be witnessed by joining diagnostic procedures in the clinic.
Education:	self study, practical training and assignment
Assessment:	report and oral exam (EC1)

Kvr4	Radiotherapy imaging and physics
Lecturer(s):	dr. B.J.M. Heijmen (b.heijmen@erasmusmc.nl) / prof.dr. P.C. Levendag (p.levendag@erasmusmc.nl) (Erasmus MC)
Description	Medical images (CT, MRI, PET-CT, ultrasound) are essential for establishing the correct radiotherapy target volume. In the fractionated treatments (treatments in ~ 35 consecutive days) there are variations in the tumor set-up relative to the treatment beams. Daily acquired images, just prior to treatment execution, may be used to correct for these variations. The daily images may also be used to accurately verify the dose of ionizing radiation delivered to the patient. This module is an introduction in the physics aspects of radiotherapy imaging and in the clinical applications. These applications will be illustrated during stays at several clinical sections of the department of radiotherapy.
Education	self study, practical training and assignment
Assessment:	report and oral exam (EC1)

Kvr5	Computer simulation methods of biological tissues or systems
Lecturer(s):	prof. dr. ir. A. Vossepoel / prof. dr. ir. H. Weinans (a.vossepoel@erasmusmc.nl, h.weinans@erasmusmc.nl) (Erasmus MC)
Description	In this course, several examples of models of biological tissues or systems will be shown, such as prostheses in bone, modeling of living systems e.g. remodeling of trabecular bone (the process by which the bone tissue of your skeleton is renewed continuously) and compression of cartilage. This module will teach how to make a computer model of a biological system, by post-processing data from imaging modalities in order to make quantitative data and using experimental data from e.g. mechanical compression or bending tests. In a practical training the students have to solve a problem using and implementing software code relative to a specific data set generated with one of the imaging modalities, such as CT or MRI and/or mechanical tests.
Education	self study, practical training and assignment
Assessment:	report and oral exam (EC1)

Kvr6	Strabismus surgery
Lecturer(s):	prof. dr. H.J. Simonsz (simonsz@compuserve.com) / ir. S. Schutte (Erasmus MC)
Description	This course will teach the anatomy and physiology of some organ systems (e.g. lung, kidney and bladder). The student will learn how to differentiate between normal and abnormal function at both the macroscopic and microscopic levels. The most relevant parameters and pathologic conditions of these organs will be presented and discussed. In addition some diagnostic methods and imaging modalities for finding organ pathology will be taught. This course consists of the first four weeks of the education for medical students in the ErasmusMC in Rotterdam.
Education	self study, practical training and assignment
Assessment:	report and oral exam (EC1)

Kvr7	General Course on Disorders of Environment & Interior
Lecturer(s):	D.J.G.M. Duncker, J. van der Steen, A.J.M. Verhoeven, R. Zietse, H. Stam (Erasmus MC)
Description	This course will teach the anatomy and physiology of some organ systems (e.g. lung, kidney and bladder). The student will learn how to differentiate between normal and abnormal function at both the macroscopic and microscopic levels. The most relevant parameters and pathologic conditions of these organs will be presented and discussed. In addition some diagnostic methods and imaging modalities for finding organ pathology will be taught. This course consists of the first four weeks of the education for medical students in the ErasmusMC in Rotterdam.
Education	lectures
Assessment:	written exam (EC 4)

Kvr8	Biomedical Image Processing
Lecturer(s):	Prof. dr. A. Vossepoel, Dr. J. Veenland, Prof. Dr. W. J. Niessen a.vossepoel@erasmusmc.nl w.niessen@erasmusmc.nl, j.veenland@erasmusmc.nl (Erasmus MC)
Description	Both in biomedical research and clinical practice, an overwhelming amount of imaging data are generated. In order to extract the relevant information from these data, e.g. for aiding in diagnosis, treatment planning, or monitoring of therapy, image processing techniques are often required. In this course, the student will be introduced into state-of-the art methods for the automated extraction of organs from medical imaging data. The student will subsequently develop code within a medical image processing environment in order to solve a number of relevant clinical applications, such as the quantitative analysis of cardiac and brain image data.
Education	self study, practical training
Assessment:	report and oral exam - (EC 1)

Appendices

6.1 Course and Examination Regulations

Section 1 GENERAL

Article 1 SCOPE AND APPLICABILITY OF THESE REGULATIONS

1. These regulations are applicable to teaching and examinations of the Master's degree programme Biomedical Engineering at Delft University of Technology, hereafter referred to as the programme.
2. These programmes are conducted under the responsibility of the Faculty of Mechanical Engineering and Marine Technology at Delft University of Technology, hereafter referred to as the Faculty.
3. For this programme, implementation procedures are in effect that supplement, and are integral to, these Course and Examination Regulations.
4. The Course and Examination Regulations and the implementation procedures are laid down by the Dean.

Article 2 DEFINITIONS

Any terms in these regulations also occurring in the Higher Education and Academic Research Act (WHW) will have the same meaning as that intended by that Act.
In these regulations, the following terms shall be understood as follows:

a. the Act: the Higher Education and Academic Research Act (abbreviated in Dutch to WHW), including its subsequent amendments;
b. programme: the Master's degree programme referred to in Article 7.3a, subsection 1 under b of the Act;
c. student: anyone enrolled at Delft University of Technology (as a student or "extraneus") for purposes of education and/or for taking the examinations and interim examinations that are part of the programme;
d. practical training: practical exercise as referred to in Article 7.13, subsection 2 under d of the Act, in one of the following forms:
   - writing a thesis;
   - writing a paper/completing an assignment, project or technological design;
   - completing a design or research assignment;
   - conducting literature study;
   - completing a work placement;
   - taking part in fieldwork or an excursion;
   - conducting tests and experiments;
   - or participating in another educational activity focused on the attainment of a particular skill.
e. interim examination: a test of a student's knowledge, insight and skills with regard to a particular unit of study, and the assessment of this examination by at least one examiner appointed for that task by the board of examiners.

h.	examination:	test used by the board of examiners to establish whether all interim examinations that are part of the study programme have been successfully completed as specified in Article 7.10 of the Act.
i.	board of examiners:	the board of examiners as appointed according to Article 7.12 of the Act.
j.	implementation procedures:	the implementation procedures integral to the Course and Examination Regulations and applicable to a specific Master's programme.
k.	working day:	each day from Monday to Friday, with the exclusion of official national holidays.
l.	course calendar:	the publication containing all the specific information appropriate to a specific Master's course guide named in Article 1.
m.	examiner:	those appointed by the board of examiners for the purpose of taking interim examinations in accordance with Article 7.12 of the Act;
n.	EC:	European Credits as specified in the European Credit Transfer System
o.	The University:	Delft University of Technology

Article 3 OBJECTIVE OF THE MASTER PROGRAMME BIOMEDICAL ENGINEERING

The goal of the master programme Biomedical Engineering is to educate graduates in Biomedical Engineering to an academic engineering level. The level corresponds to the technological borders of a specific discipline. The graduates are capable:

- To identify, define and analyse problems, for the solution to which biomedical-engineering principles and techniques can contribute
- To develop and to produce a sound solution to the problem
- To present these solutions effectively

Article 4 ADMISSION TO THE MASTER'S PROGRAMME

1. Admission to this programme will be granted to students in possession of a degree issued for the Bachelor's programme in Mechanical Engineering, Aerospace Engineering, Electrical Engineering, Industrial Design, Marine Technology, Civil Engineering, Applied Physics and Biomedical Engineering issued by the Delft University of Technology, Technische Universiteit Eindhoven, University of Twente or one of the universities of the IDEA-league.
2. Students who are not graduates of one of the courses specified in paragraph 1 but who are in possession of a confirmation of admission provided by the Faculty will be eligible for admission.
3. To obtain confirmation of admission, a student must satisfy the criteria specified in paragraph 1.4 of the study guide.
4. If so requested by a student who is not in possession of a Bachelor's degree as specified in paragraph 1, the board of examiners may depart from paragraph 1 by allowing that student to attend parts of the Master's programme.

Article 5 FINAL QUALIFICATIONS OF THE MASTER PROGRAMME BIOMEDICAL ENGINEERING

The graduated Master of Biomedical Engineering meets, to a sufficient level, the following qualifications:

1. Broad and profound knowledge of engineering sciences (applied physics and mathematics) and the capability to apply this knowledge at an advanced level in the variant-related discipline.

2. Broad and profound scientific and technical knowledge of the variant-related 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 in part the forefront of scientific or industrial research and development. The knowledge is the basis for innovative contributions to the discipline in the form of new designs or development of new knowledge.
3. Thorough knowledge of paradigms, methods and tools as well as the skills to actively apply this knowledge for analysing, modelling, simulating, designing and performing research with respect to innovative variant-related systems, with an appreciation of different application areas.
4. Capability to independently solve 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 lacking expertise, monitoring and critically evaluating existing knowledge, planning and executing research, adapting to changing circumstances, and integrating new knowledge with an appreciation of its ambiguity, incompleteness and limitations.
5. Capability to work both independently and in multidisciplinary teams, interacting effectively with specialists and taking initiatives where necessary.
6. Capability to effectively communicate (including presenting and reporting) about one's work such as solutions to problems, conclusions, knowledge and considerations, to both professionals and non-specialised public in the English language.
7. Capability to evaluate and assess 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.

Article 6 FULL-TIME AND PART-TIME COURSE FORMAT

The Master's programme will be provided on a full-time basis.

Article 7 LANGUAGE

1. English shall be the language used for all teaching and examinations.
2. In certain cases, the Dean may depart from paragraph 1 by giving permission for teaching to take place in Dutch, if this is necessitated either by the specific nature of the organisation, the quality of the course, or the students' origins and backgrounds.
3. If a student asks to be allowed to take one component, or several components, of an examination in a language other than English, the terms of the regulations and the guidelines of the board of examiners will be applicable accordingly.

Section 2 COMPOSITION OF THE MASTER'S PROGRAMME AND THE FINAL EXAMINATION

Article 8

1. The composition of the educational programme is laid down in the implementation procedures. This educational programme starts once a year, in September.
2. The examination for a Master's Degree is an integral part of the programme. The study load for this examination totals 120 EC.

Section 3 INTERIM EXAMINATIONS

Article 9 THE NUMBER, PERIOD AND FREQUENCY OF INTERIM EXAMINATIONS

1.a. The course shall provide at least two opportunities per year to sit interim examinations:
- the first shall follow immediately after the teaching period in which the relevant component was taught and completed;
- the second shall be given at the end of the second semester, or otherwise in the August resit period.

1.b. The interim examinations referred to under a. shall be held as indicated for the unit of study concerned in the timetable for the current academic year. At the beginning of each academic year, a timetable specifying the dates and times of written interim examinations shall be drawn up and published.

2. In the event that a course component is not taught within the Faculty itself, and therefore there is no indication of the number of times it is possible to sit an interim examination as referred to in paragraph 1, the course and examination regulations of the relevant Faculty or degree programme will be applicable, provided no decision to the contrary has been taken by the board of examiners.

3. Notwithstanding the provisions of the first clause under 1a, at least one opportunity shall be given per year to take an interim examination in a course component that has not been taught in that year.

4. In certain cases the board of examiners may allow departures from the specified number of times that an interim examination can be sat.

Article 10 THE ORDER OF INTERIM EXAMINATIONS

The implementation procedures shall specify the order in which the interim examinations will be taken, or in which students be to participate in practical training.

Article 11 THE PERIOD OF VALIDITY OF INTERIM EXAMINATIONS

1. Students who have interrupted their studies, or who have delayed their studies for other reasons, shall resit any component they passed ten years or more ago if its contents have since been modified.

2. The board of examiners may, in a student's favour, depart from the provisions of paragraph 1.

Article 12 THE FORM OF THE INTERIM EXAMINATIONS, AND THE METHOD OF TESTING

1. Per year, the form in which each interim examination is to be taken shall be specified in the study guide for the actual course year under the unit of study concerned.

2. If no specification is made of the way in which an interim examination can be taken, because that examination applies to a unit of study that is not taught within the Faculty, and because it involves a unit of study that is not specific to students taking part in a programme administered by the Faculty of 3mE, the relevant conditions in the Course and Examination Regulations for that unit of study shall be applicable. Each year, the board of examiners under which the interim examination falls shall determine the way in which the interim examination is to be taken.

3. The appointed examiner may depart from the provisions of paragraphs 1 and 2 in a student's favour. Each student with a physical or sensory disability shall be given the opportunity to take all interim examinations and practical training in a way that, to the greatest possible extent, is adapted to the disability in question. Under this facility, the form or length of the interim examinations shall be adapted to the individual situation, or practical aids shall be made available.
4. The facilities specified in the previous paragraph should be requested from the board of examiners by the student concerned. This request should be accompanied by a medical certificate issued no more than one year previously by a doctor, psychologist or student counsellor. All requests involving dyslexia should be backed by a recognised dyslexia testing body.

Article 13 ORAL INTERIM EXAMINATIONS

1. Unless otherwise determined by the board of examiners, no oral interim examination shall involve more than a single student at the same time.
2. All oral interim examinations be public, unless, in exceptional circumstances, the board of examiners or the individual examiner decide otherwise, or if the student has submitted an objection.

Article 14 THE ESTABLISHMENT AND NOTIFICATION OF RESULTS

1. Immediately after taking an oral interim examination, the examiner shall announce the result, and issue the student with the relevant written notification.
2. As soon as possible after a written interim examination, and always within a maximum of 15 working days, the examiner shall declare the results. The examiner shall provide the Faculty's student administration office with the necessary details. Paying all due attention to the privacy of individual students, the student administration office shall take responsibility for the registration, publication and reporting of the results within 20 working days of the interim examination.
3. If an interim examination is taken neither in writing nor orally, but in another form, the board of examiners shall decide in advance on the way in which students will be notified of the results, and of the period within which this will occur.
4. When students be provided with written notification of the results of an interim examination, it shall at all times be made clear that they have the right to inspect the relevant examination documents (as defined in Article 15), and that they have the right to appeal to the examination appeals board.

Article 15 CANDIDATES' RIGHT TO INSPECT THEIR EXAMINATION DOCUMENTS

1. For at least one month after the results of a written examination have been announced, it shall be possible for students to inspect their examination and its assessment. At the student's request, he/she will be provided with a copy of the relevant work at cost price.
2. During the period specified in paragraph 1, it is possible for all interested parties to inspect the questions and assignments of the relevant interim examination, and also the norms whereby assessment took place. Upon request a copy of this information shall be provided at cost price.
3. The board of examiners may specify that inspection of examination documents will take place at a predetermined place at no fewer than two predetermined times. The place and dates shall be stated on the list of results. If a student can demonstrate that, due to forces beyond his or her control, it was impossible to be present at the predetermined place and time, a new opportunity shall be provided; if possible, this shall fall within the period specified in paragraph 1.

Article 16 OPTIONS FOR DISCUSSING THE RESULTS OF AN INTERIM EXAMINATION

1. As soon as possible after the results of an interim examination have been announced, student or examiner may take an initiative towards discussing the examination, and to explaining its assessment.
2. For a period of one month, starting on the day following the announcement of the results, a student who has taken a written interim examination may apply to the relevant examiner to discuss the work in question. This discussion shall follow at a place and time specified by the examiner, and always within a reasonable period.
3. If, for whatever reason, the board of examiners organises a collective discussion after an interim examination, there be only two cases in which a student may submit a request of the type specified in the previous paragraph: either a. by being present at the collective discussion and by simultaneously providing the motives for the request; or b. when, due to circumstances beyond his or her control, it was impossible to attend the collective discussion.
4. The conditions of the previous paragraph shall also apply if the board of examiners or the examiner provides the student with an opportunity to compare his or her answers with standard answers.
5. The board of examiners may allow deviations from the stipulations of paragraphs 3 and 4.

Section 4 EXEMPTION FROM INTERIM EXAMINATIONS

Article 17 EXEMPTION FROM INTERIM EXAMINATIONS OR PRACTICAL EXERCISE

1. The board of examiners can grant students exemption from one or more interim examinations or practical exercises, if they have satisfied the examiners either with regard to earlier interim examinations, or with regard to Higher Education examinations, or with regard to knowledge and skills acquired outside higher education. However, this is possible only if they satisfy at least one of the following conditions:
   a. the interim examination involved a unit of study that, in terms of content and study load, was equivalent to a comparable university course in the Netherlands or beyond, or at an institute of professional education (i.e. HBO institute / hogeschool) in the Netherlands.
   b. the student can provide proof of knowledge or experience acquired either during a course provided somewhere other than at a Dutch institute of professional education, or otherwise during activities conducted in another context.
2. If the relevant examiner has made a fully motivated proposal to this effect, the board of examiners may grant exemption from an interim examination.

Section 5 THE MASTER'S EXAMINATIONS

Article 18 PERIODS AND FREQUENCY OF EXAMINATIONS

1. An opportunity to take the Master's examination shall be provided no less than twice a year. In a meeting held before the start of the academic year, the board of examiners shall establish the dates on which the examinations be to be held. These shall be published in the study guide for the programme and year in question.

2. All students can apply to take the examinations as soon as they have fulfilled the conditions of their course, and have provided the student administration office with proof of the course components they have passed.

Article 19 REPORTING ON STUDENTS' PROGRESS

1. At least once a year, each student shall be sent a written report on the progress he or she has made over the preceding period.
2. The report referred to in paragraph 1 shall be composed according to the guidelines established by the Executive Board.
3. The Dean shall be responsible for supervising the progress of all students enrolled on the course. Such supervision shall include an assessment of the options for study that be available to students, both inside the programme and beyond it.

Section 6 PROVISIONS FOR IMPLEMENTATION

Article 20 MODIFICATION OF THE REGULATIONS

1. These regulations may be modified in a special decision by the Dean.
2. No decision shall be made in respect of the current academic year, unless, by all reasonable definitions, it is unlikely to damage the interests of students.
3. No change in the regulations may negatively affect a previous decision made by the board of examiners in respect of a student.

Article 21 TRANSITIONAL RULING

1. In the event that the composition of a teaching programme is modified, or that one of the Articles of the Course and Examination Regulations is changed, the Dean shall decide on a transitional ruling, which shall then be published in the implementation procedures.
2. In all cases, this transitional ruling shall incorporate the following:
   a. a ruling on the exemptions that be available on the basis of interim examinations that a student has already passed,
   b. the number of times that it is still possible to sit for interim examinations under the conditions of the old programme,
   c. the period for which the transitional ruling will be valid.

Article 22 PUBLICATION OF THE TRANSITIONAL RULING

1. The Dean shall take responsibility for publicising the following in an appropriate fashion: the transitional ruling defined in Article 21, and the implementation procedures and the changes to it.
2. The Course and Examination Regulations and the implementation procedures for each course shall be incorporated in the study guide.

Article 23 DATE OF COMMENCEMENT

These regulations shall come into force on 1 September 2005.

6.2 Implementation Procedures

for the teaching and examination regulations appropriate to the Master's programme Biomedical Engineering

Article 1 COURSE CALENDAR

The course calendar for the programme can be found in the Study Guide for the Master's degree programme Biomedical Engineering.

Article 2 COMPOSITION OF THE PROGRAMME

The composition of the Master's degree programme Biomedical Engineering, including number of credit points, assessment, entrance requirements per unit of study is described in the Study Guide.

Article 3 COMPOSING FLEXIBLE STUDY PROGRAMMES

1. Students may themselves compose an individual study programme that will lead to an examination. This programme must consist, either in full or for the greater part, of units of study which be taught on the course they be attending, and may be supplemented with units taught on other courses or at other universities.
2. Each student desiring to compose a programme of the sort referred to in paragraph 1 shall submit his or her own proposal, motivating it in full, for the approval of the relevant board of examiners, i.e. at the beginning of the Master's programme.

Article 4 PROCEDURE FOR APPROVING FLEXIBLE STUDY PROGRAMMME

1. No less than two months before they intend to start on a flexible study programme, all students must submit their proposals for their choices of one or more units of study (as referred to in Article 3) for approval by the board of examiners. Each proposal must be accompanied by a clearly argued motivation.
2. Any decision not to approve the proposal shall be motivated by the board of examiners after the student in question has been given the opportunity of a hearing.
3. The board of examiners shall decide within twenty working days of receiving the application, or, if the application is submitted during an academic holiday, no more than ten working days after this holiday has ended.
4. The board of examiners can adjourn its decision for no more than ten working days. The student shall be given written notification of such adjournment within the twenty-working-day period referred to in the first sentence of paragraph 3. The student shall receive written notification of the decision without delay.

Article 5 THE ORDER OF INTERIM EXAMINATIONS AND ASSIGNMENTS

The order in which the interim examinations will be taken, assignments shall be fulfilled or in which students be to participate in practical training, is laid down by means of entrance requirements, specified in the description of the contents of the programme in the Study Guide.

Article 6 MASTER'S THESIS

1. The programme is concluded by fulfilling a final assignment and presenting a Master's thesis.
2. The Master's thesis is assessed by an examining committee, assigned by the board of examiners.
3. The student applying for the Master's examination has to defend his thesis before the examining committee mentioned sub 2.

Article 7 VARIANTS AND ANNOTATIONS

1. The Biomedical Engineering MSc-programme is provided in only one variant.
2. As an addition to the programme there is an annotations. After completing such an annotation, the student acquires a supplement to the MSc-degree, which declares a more than average knwoledge about that subject. The annotation is:
   - Technical Marketing
3. Further details and requirements be laid down in the study guide.

Article 8 PARTICIPATION IN THE PROJECT "TU DELFT HELPS REDUCE THE SHORTAGE OF TEACHERS"

Within the framework of the project "TU Delft helps reduce the shortage of teachers in Dutch pre-university education", students can take part in the course "TU Delft/Teachers for schools". This course comprises two parts, a preparatory course and a supervision phase. The total course leads to the award of 9 EC, which should be allocated within the elective subjects.

Laid down by the Dean of the Faculty 3mE, after the approval of the Faculty's Student Council, and after considering the recommendations provided by the education committee on 1-9-2005.

6.3 Regulations and guidelines for the board of examiners

Article 1 SCOPE OF THE REGULATIONS

These regulations and guidelines are applicable to the teaching of, and examinations for, the Master's degree programme in Biomedical Engineering, hereafter referred to as the programme.

Article 2 DEFINITIONS

1 When used in these regulations and guidelines, the term Course and Examination Regulations (CER), refers to the current course and examination regulations as intended under Article 7.12 of the Higher Education and Academic Research Act (abbreviated in Dutch as WHW):
2 All other terms occurring in these Regulations will have the same meaning as that intended in the CER and the WHW.

Article 3 DAY-TO-DAY ADMINISTRATION

The board of examiners consists of the lecturers who are engaged in the educational programme and mentioned as such in the curricula, described in section 1.5 of the study guide. The board of examiners shall appoint a chair and a secretary from its members. The chair shall be responsible for the day-to-day management of the committee.

Article 4 MASTER'S EXAMINING COMMITTEE

1. The board of examiners appoints a Master's examining committee for the assessment of each Master's thesis.
2. A master's examining committee consists of no less than three members.
3. The professor in charge is chairman of the committee.
4. No less than one member belongs to the scientific staff of the section responsible for the specialisation concerned; no less than one member belongs to the scientific staff of a different section of Delft University of Technology.
5. The committee can be completed by experts from outside the University.

Article 5 ENTRY FOR INTERIM EXAMINATIONS

1 Students shall apply for interim examinations at the Faculty's Department of Educational and Student Affairs by entering data in the examination application system, or, if the system is not in use, by completing and submitting a form made available by the Department of Educational and Student Affairs. Whatever the means of application, all submissions must be received no less than ten working days before the interim examination.
2 In exceptional cases, the board of examiners can depart from the application period defined in paragraphs 1 and 4 of this Article, provided that this departure is in the favour of the student concerned.
3 Admission to the interim examination will be granted solely to those students who are registered on the list of applicants produced by the examination application system (or by any alternative system currently in force).

4 If, in their opinion, students have not been able to apply for an interim examination due to events beyond their control, they shall apply to the board of examiners no less than two full working days before the day for which the examination is planned. By submitting a declaration of demonstrable force majeure written or issued by, or on behalf of, the board of examiners, the student may be allowed to sit the relevant examination.

Article 6 ORDER DURING AN INTERIM EXAMINATION

1 With regard to written interim examinations, the board of examiners and/or the appointed examiner shall be responsible for appointing invigilators who, on behalf of and under the authority of the board of examiners will ensure that the examination runs smoothly.

2 If asked by, or on behalf of, the board of examiners, all candidates shall identify themselves by showing their campus card.

3 Candidates shall observe all instructions that have been published before the start of the examination by the board of examiners, or by the examiner or invigilator. They shall also follow instructions given during the examination and immediately after it has finished.

4 If a candidate fails to fulfil the conditions of the paragraphs 2 and 3 of this Article, the board of examiners or the appointed examiner can exclude him or her from further participation in the interim examination. The consequence of such exclusion is that no result is established for the examination in question. Before taking such a decision, the board of examiners shall offer the student concerned an opportunity to state his or her case.

5 The time allotted for each interim examination shall, by all reasonable standards, be long enough to allow candidates sufficient time to answer its questions.

6 When the interim examination has finished, candidates may keep the assignment papers. The exception to this rule concerns examinations in which questions and answers must be handed in together.

7 Candidates may not enter the examination room until the invigilator gives permission.

8 No candidates are admitted into the examination room no later than half an hour after the official start of the examination.

9 Candidates are not allowed to leave the examination room within the first half hour following the official start of the examination. After this time, permission to leave the room temporarily will be given only in urgent cases. No more than any one candidate may be absent at the same time.

10 Under no circumstances my items such as briefcases, bags and mobile telephones be used or handled in the examination room.

11 Although candidates are responsible for bringing their own calculators and their own writing and drawing materials, the faculty will provide answer sheets and scrap paper.

12 In the event that a certain examination requires students to use calculators, these calculators may at no time be able to exceed the maximum capabilities specified by the examiner for that subject. In general, programmable calculating equipment is not allowed. (Generally examination assignments should be formulated such that they can be carried out with a simple calculator; at no times should candidates with more complex calculators have an advantage.)

13 Candidates may not write their answers in pencil, unless the lecturer has given prior permission for this.

14 During the interim examination, candidates may not consult books, readers, etc., unless the lecturer has given prior permission for this.

15 If an invigilator catches a candidate or candidates cheating, the procedure described in Article 6, paragraph 2 of these regulations will be applicable.

16 Before permanently leaving the examination room (i.e. no less than 30 minutes after the start of the interim examination), candidates must, at minimum, submit the front page of the answer sheet. This must bear their name and student number.

17 Before the interim examination begins, the invigilator shall instruct the candidates on the procedure they must follow if they leave the examination room without completing all the examination assignments.

18 Students who believe they may qualify for examination in a different form, should, as specified in Article 12 paragraphs 4 and 5 of the CER[1], submit a fully motivated request for this to the chair of the board of examiners.

Article 7 CHEATING

1 Cheating is defined as any act committed by a student for the purpose of making it partly or wholly impossible to make a correct assessment of his or her knowledge, insight and skills.

2 If a student is found to be cheating as defined in paragraph 1 of this Article, the board of examiners can decide to exclude him from the interim examination in question.

3 The decision to exclude a student as defined in paragraph 2 of this Article shall be taken on the basis of the invigilator's report of the cheating.

4 In urgent cases, the invigilator is entitled to act on behalf of the board of examiners by immediately excluding the student or students concerned. The board of examiners shall ensure that, immediately after the interim examination, the report defined in paragraph 3 of this Article is made in writing; and that a copy is issued to the student or students concerned.

5 Within 20 days of his or her exclusion, such a student may appeal to the board of examiners to reverse their decision. To this appeal, the student will attach a copy of the report defined in paragraph 4 of this Article; this may also be accompanied by the student's own written testimony.

6 Before deciding on an appeal of the sort defined in paragraph 5 of this Article, the board of examiners shall give both student and examiner the opportunity of a hearing.

7 The board of examiners will decide on any reversal of the original decision within 30 working days of receiving the student's appeal.

8 The consequence of exclusion is that no examination result will be recorded for the interim examination intended under paragraph 2 of this Article.

9 In the event of cheating, the board of examiners can decide, conditionally or unconditionally, to exclude the student from all further interim examinations for a maximum period of one year.

[1] Course and Examination Regulations

Article 8 CRITERIA

When taking the decisions that are integral to their duties, the board of examiners and, where appropriate, the examiner, shall be guided by the criteria stated below. When these criteria conflict, the board shall carefully weigh the interests of allowing one criterion to prevail over another. At all times, these standards must ensure that the following conditions are met:

a that the criteria regarding quality and selection inherent to an interim examination are maintained;
b that the need for efficiency is met, particularly by limiting to a minimum any time loss that would hinder those students whose preparations for examinations and interim examinations are running to schedule;
c that students who wish to assume too great a study load should be protected from themselves;
d that clemency should be shown in all cases in which students' progress is slowed by circumstances beyond their control.

Article 9 QUESTIONS AND ASSIGNMENTS

1 The scope of an interim examination, and the sources upon which it is based, shall be announced no less than a month before that examination takes place. No questions or assignments in the examination may go beyond the scope of these sources.
2 To the greatest possible extent, the questions and assignments of each interim examination shall be evenly distributed over the material being examined.
3 Both in content and form, each interim examination shall represent the learning objectives stated.
4 All questions and assignments shall be clear and explicit.
5 Well in advance of each interim examination, the board of examiners or the examiner shall announce the form of examination and method of testing as meant under Article 12 of the CER.
6 Well in advance of each written interim examination, the board of examiners or the examiner shall provide an opportunity whereby students intending to participate in it can examine a similar test on the same subject, together with sample answers and the norms that would be applied during its assessment.

Article 10 ASSESSMENT

1 The assessment of an interim examination is expressed in whole numbers on a scale from 1 to 10, with 6 signifying a pass. If desired, practical training can also be assessed as a "pass" or a "fail". All exemptions for a subject are treated as a 6, i.e. a pass.
2 Students pass their Master's examinations by satisfying the examiners in each component of the Master's programme. Students awarded a 5 in a single subject excepting the thesis project will also qualify for the award of their Master's degree.
3 Per subject, the highest mark awarded for an interim exam will be recorded on the examination certificate.

Article 11 THE ESTABLISHMENT OF EXAMINATION RESULTS[2]

1 The votes of the board of examiners shall be established by a simple majority of votes.
2 If the votes are equally divided, the chair of the board of examiners shall have the casting vote, unless the vote takes place in writing.

[2] For the period within which students shall be notified of the results of interim examinations, see Article 14 of the Course and Examination Regulations (CER) for the Master's degree programmes.

3 If, in a written vote, the votes are equally divided, there shall be a second ballot. If this, too, leads to an equal division of votes, the proposal being balloted shall be rejected.

Article 12 CUM LAUDE

1 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, excluding the mark awarded for the Master's thesis project, shall average no less than 8 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".

2 When establishing the elapsed study time referred to in paragraph 1 subsection b of this Article, all due account should be taken of any delays caused by circumstances qualifying the candidate for support under the "Regeling Financiële Ondersteuning Studenten" (RFOS)

3 At all times, the board of examiners has the authority to decide on awarding the designation "cum laude" in cases that fall outside the provisions defined above.

Article 13 MASTER'S DEGREE CERTIFICATES AND STATEMENTS

1 To establish that a candidate has satisfied the examiners in the Master's examinations, the board of examiners shall issue a degree certificate. This shall be signed by the chair and the secretary to the board of examiners.

2 a The degree certificate as intended under paragraph 1 shall list the specific components of the examination, and, where appropriate, the competencies associated with them.

b The degree certificate shall be accompanied by marks lists in both Dutch and English.

3 If a candidate's performance during the examinations testifies to exceptional abilities, the board of examiners can, under the conditions stated in Article 11 of these Regulations, decide to grant the designation "cum laude" on the degree certificate.

4 Any student who has successfully completed more than one interim examination and to whom, upon his or her leaving the university, a degree certificate as intended in paragraph 1 of this Article cannot be awarded, shall, upon his or her request, receive a statement from the board of examiners in question.

Article 14 PROCEDURE FOR APPROVALS

1 Any student wishing to submit a request as intended under Article 7.3 paragraph 4 of the WHW (i.e. with regard to a flexible study programme) should do so on a timely basis, ensuring that, by all reasonable definitions, there is time for approval to be given before he or she takes the first interim examination. In this, he or she should take full account of the period within which the board of examiners is entitled to decide (see Article 14, paragraph 1). The request shall be accompanied by a clearly argued motivation, and, if necessary, by material that supports it.

2 Students shall submit to the board of examiners any requests for exemption from an interim examination or practical exercise as intended under Article 17 of the CER. The board of examiners shall decide on this after taking advice from the student counsellor. The periods within which decisions shall be taken are defined in Article 14, paragraph 2 of these Regulations and Guidelines.

3 If a student wishes to depart from the teaching programme prescribed in the implementation procedures, he or she shall submit a request to this effect, ensuring that, by all reasonable definitions, there is time for approval to be given before the date of the first interim examination that deviates from that programme. In this, full account should be taken of the period within which the board of examiners is entitled to decide (see Article 13, paragraph 1).

4 A decision to withhold approval for a request of the type intended under paragraphs 1, 3 and 4 of this Article must be fully motivated by the Board of Examiners, and may only be made after the student has been given the opportunity of a hearing, where the student may call upon the assistance of the student counsellor.

5 The student will immediately be informed in writing of a decision on any of the matters intended under paragraphs 1, 2, 3 and 4 of this Article. If the board of examiners concerned has not made a decision during the time period prescribed in article 14, paragraph 1, or otherwise during the period of adjournment, approval will be understood to have been granted.

Article 15 TIME PERIODS

1 A decision on a request such as those described in Article 13, paragraph 1 or 4 shall be made within 40 working days of its receipt; or, if the request was submitted either during an academic holiday or within a period of three weeks before the start of an academic holiday, it shall be made within a period of 40 working days after the end of the holiday. The board of examiners may adjourn a decision for no more than 10 working days. The student will be notified in writing of any such adjournment before the end of the 40-day period specified in the first sentence of this paragraph.

2 The provisions of the previous paragraph will also be applicable to requests such as those described in Article 13 paragraph 3, on the understanding that the time period will start from the moment that the recommendations of the student counsellor have been submitted. The student counsellor shall submit these recommendations to the board of examiners no more than 10 working days after receiving the student's request.

Article 16 RIGHT OF APPEAL

Within four weeks of the event in question, students can appeal to the examinations appeals board against the following: a ruling by the board of examiners, a ruling by an examiner, or their treatment during an examination as defined in Article 7.60 WHW.

Article 17 MODIFICATION OF THESE REGULATIONS AND GUIDELINES

No decision shall be made in respect of the current academic year, unless, by all reasonable definitions, it is unlikely to damage the interests of students.

Article 18 DATE OF COMMENCEMENT

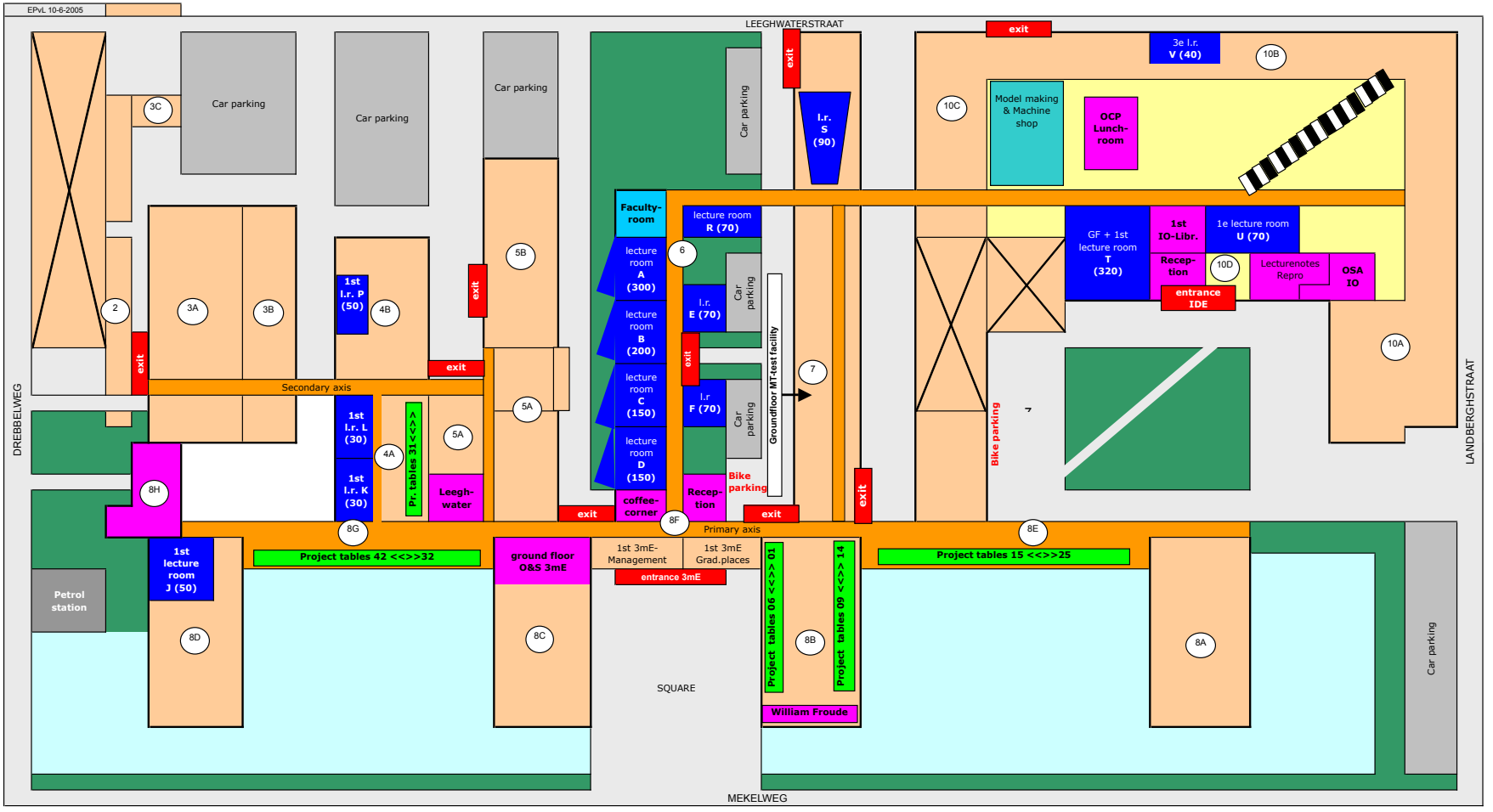
These regulations will come into effect on 1 September 2005.
Approved by the board of examiners of the Master's programme in Biomedical Engineering.

6.4 Campus Map

Legend Campus map

3	Faculty Applied Earth Sciences	36	Faculty Electrical Engineering, Media and Knowledge technology, Technical Computer Science and Technical Mathematics
5	Faculty Life Science and Technology, Botanical Garden	34	Faculty Mechanical, Maritime and Materials Engineering (3mE), Board of Governors, Staff Board of Governors, TopTech Courses
6	VSSD	37	Sports center
7	Alumni Desk, Facilitating Service	38	Cultural Center 'Mekelweg 10', Studium Generale
10	Master of Science International Programme	40	Faculty Technical Material Sciences
12	Faculty Chemical Technology	41	Service Technical Support
20	Auditorium, Congress center, University foundations Delft, TU Shop	43	Energy and Building Management
21	Library TU Delft, Delft University Press	45	Doc Vision Support Center Delft
22	Faculty Technical Physics	46	Machinery design for the process industry
23	Faculty Civil Technology, Management center for International Cooperation	52	Faculty Geodesy
24	Faculty Architecture	60	Logistics and Milieu Services
31	Faculty Technical Management Science	62	Faculty Aerospace Engineering
32	Faculty Industrial Design		

A description and the exact adresses of all the numbers can be found on the homepage of the TU Delft. In this table are only the numbers published which are of interest for the student of the MSc course Mechanical Engineering or Marine Technology.



3A	3mE Dep. Materials Science & Engineering (from june 2006)
3B	3mE Dep. Materials Science & Engineering (from june 2006)
3C	3mE Formula Student, NUNA, etc.
4A gf	3mE Mechanical Engineering design studio's and BSc project tables
4A 1st	3mE Labs Mechatronics + PC-rooms
5A	3mE Dep. Precision Micro-systems Engineering
5A	3mE Dep. Delft Center for Systems & Control
5B	3mE Dep. Proces & Energy
6	3mE Lecture rooms A - F + R + Faculty room
7 gf	3mE Marine & Transport Technology (Test Facility)
7 1st	3mE Marine & Transport Technology (Marine Technology)
8B gf	3mE BSc Project tables + William Froude
8B 1st	3mE Marine & Transport Technology
8B 2nd	3mE Dep. Precision Micro-systems Engineering
8B 3rd	3mE Dep. Precision Micro-systems Engineering
8B 4th	3mE Dep. Precision Micro-systems Engineering
8C gf	3mE Offices O&S and M&C
8C 1st	3mE Dep. Biomedical Engineering
8C 2nd	3mE Dep. Delft Center for Systems & Control
8C 3e	3mE Dep. Delft Center for Systems & Control
8C 4e	3mE Dep. Delft Center for Systems & Control
8D gf	3mE Graduation places
8D 1st	3mE Dep. Materials Science & Engineering (from june 2006)
8D 2nd	3mE Dep. Materials Science & Engineering (from june 2006)
8D 3rd	3mE Dep. Materials Science & Engineering (from june 2006)
8D 4th	3mE Dep. Materials Science & Engineering (from june 2006)
8E	3mE BSc project tables
8F bg	Reception WbMT
8F 1st	3mE management + graduation places
8G	3mE BSc project tables
8H	TUD University Board
10A bg	IDE PC-clusters
10A 1e	IDE Design Studio's DE
10A 2e	IDE Design Studio's + lab. DE
10A 3e	IDE DE
10A 4e	IDE DE
10B bg	PMB Welding Shop + ware house
10B 1e	IDE Design Studio's
10B 2e	IDE labs ID
10B 3e	IDE ID
10B 4e	IDE ID + PIM + study advisor + FM
10C bg	IDE Modelmaking & Machine Shop
10C 1e	IDE Photographer + AV-supplies
10D bg	IDE recept. + O&S + Copy Shop
10D 1e	IDE Library


Vector