Biomedische Technologie OW 2012

Department of Biomedical Engineering,
Eindhoven University of Technology

Quality Assurance Netherlands Universities (QANU)
Catharijnesingel 56
PO Box 8035
3503 RA Utrecht
The Netherlands

Phone: +31 (0) 30 230 3100
Telefax: +31 (0) 30 230 3129
E-mail: info@qanu.nl
Internet: www.qanu.nl

Project number: Q389

© 2012 QANU
Text and numerical material from this publication may be reproduced in print, by photocopying or by any other means with the permission of QANU if the source is mentioned.

CONTENTS

This report was finalized on 17-12-2012

Report on the bachelor's programme Biomedical Engineering and the master's programmes Biomedical Engineering and Medical Engineering of Eindhoven University of Technology

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Biomedical Engineering

Name of the programme:	Biomedical Engineering
CROHO number:	56226
Level of the programme:	bachelor
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	
Location(s):	Eindhoven
Mode(s) of study:	full time, part time
Expiration of accreditation:	31-12-2013

Master's programme Biomedical Engineering

Name of the programme:	Biomedical Engineering
CROHO number:	66226
Level of the programme:	master
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	
Location(s):	Eindhoven
Mode(s) of study:	full time, part time
Expiration of accreditation:	31-12-2013

Master's programme Medical Engineering

Name of the programme:	Medical Engineering
CROHO number:	60344
Level of the programme:	master
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	
Location(s):	Eindhoven
Mode(s) of study:	full time, part time
Expiration of accreditation:	31-12-2013

The visit of the assessment committee Biomedische Technologie OW 2012 to the Department of Biomedical Engineering of Eindhoven University of Technology took place on 10 and 11 October 2012.

Administrative data regarding the institution

Name of the institution:	Eindhoven University of Technology
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Biomedical Engineering and the master's programme Biomedical Engineering and Medical Engineering consisted of:

- Prof. dr. ir. J. Vander Sloten, professor in Engineering Sciences KU Leuven, Belgium;
- Dr. ir. J.J. Struijk, associate professor Department of Health Science and Technology, Aalborg University Denmark;
- Prof. Dr. Ir. J.A.E. Spaan, Emeritus professor in Medical Physics, University of Amsterdam;
- Prof. Dr. R. Reilly, professor in Neural Engineering, Trinity College Dublin;
- J.Y. de Boer, bachelor student Biomedische Technologie Universiteit Twente

The committee was supported by drs. L. van der Grijspaarde, who acted as secretary.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation

The assessment of the *bachelor's programme Biomedical Engineering* and the *master's programmes Biomedical Engineering* and *Medical Engineering* of Eindhoven University of Technology is part of a cluster assessment of seven Biomedical Engineering degree programmes offered by four universities. The entire cluster committee consists of six members. The kick off meeting for the cluster assessment was scheduled on 13 September 2012. During this meeting the committee members received an introduction into the assessment framework and evaluation procedures and the committee agreed upon its general working method. Furthermore the domain specific requirements and the most recent developments concerning the Biomedical Engineering domain were discussed. These domain specific requirements and the actual context form the starting point for the evaluation of the quality of the degree programmes.

In preparation of the assessment of the programme a self-assessment report was prepared by the programme management. This report was sent to QANU and, after a check by the secretary of the committee to ensure that the information provided was complete, forwarded to the committee members. The committee prepared the site visit by studying the self-

assessment report and a number of master theses. The secretary of the committee selected fifteen theses randomly and stratified out of a list of all graduates of the last two years. The following stratification is used: five theses with low grades (6-6.5), five theses with middle ranged grades (7-8) and five theses with high grades. QANU asked the programme to send the theses including the assessment by the supervisor and examiner and divided them among the committee members; each committee member therefore assessed three theses.

In the case that a thesis would have been assessed as questionable or unsatisfactory by a committee member, a reassessment was done by another committee member. In the case that more than 10% of the theses were assessed as questionable or unsatisfactory by two committee members the selection of theses for the programme was extended to 25.

Site visit

The committee members formulated questions raised by studying the self-assessment report in advance. These questions were circulated in the committee.

The committee visited the programme on 10 and 11 October 2012. The programme of the site visit was developed by the committee's secretary in consultation with the programme management and the chair of the committee. The committee interviewed, next to students, teachers and alumni, the programme management and representatives of the Faculty Board, the Examination Board and the student and teacher members of the Programme committee. An open office hour was scheduled and announced (but not used).

During the site visit the committee studied additional material made available by the programme management. Appendix 7 gives a complete overview of all documents available during the site visit. The last hours of the site visit were used by the committee to establish the assessments of the programme and to prepare the presentation of the findings of the committee to the representatives of the programme.

Report

The secretary wrote a draft report based on the findings of the committee. The draft report has been amended and detailed by the committee members. After approval of the draft report by the committee it was sent to the Department for a check on facts. The comments by the Department were discussed in the committee, this discussion resulted in some changes in the report and subsequently the committee established the final report.

The assessment was performed according to the NVAO (Accreditation Organization of the Netherlands and Flanders) framework for limited programme assessment (as of 20 November 2011). In this framework a four-point scale is prescribed for both the general assessment and assessment of each of the three standards. The committee used the following definitions for the assessment of both the standards and the programme as a whole.

Decision rules

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory

The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

General Assessment

When standard 1 or standard 3 is assessed as 'unsatisfactory', the general assessment of a programme is 'unsatisfactory' .

The general assessment of the programme can be good when at least two standards, including standard 3, are assessed as 'good',

The general assessment of the programme can be excellent when at least two standards, including standard 3, are assessed as 'excellent'.

Summary judgement

This report presents the findings and considerations of the committee that assessed the *bachelor's programme Biomedical Engineering,* the *master's programme Biomedical Engineering* and the *master's programme Medical Engineering* of Eindhoven University. The committee studied the information available and discussed the programmes with representatives of the institution and the programme during a site visit. The committee weighted their positive comments along with their points for improvement and concluded that the programmes meet the current generic quality standards and shows an acceptable level across its entire spectrum. Therefore, the committee assesses the *bachelor's programme Biomedical Engineering,* the *master's programme Biomedical Engineering* and the *master's programme Medical Engineering* as satisfactory.

In September 1997, the Engineering education programme Biomedische Technologie (Biomedical Engineering) started at the TU/e. In September 2002, the Bachelor-Master structure was formally adopted. A three year Bachelor's degree in Biomedical Engineering was coupled to two different two year Master's degrees: *Biomedical Engineering* and *Medical Engineering.* The *master's programme Biomedical Engineering* is strongly research oriented, while the *master's programme Medical Engineering* combines the research orientation with clinical components. Therefore, *master's programme Biomedical Engineering* education almost completely takes place in the university environment, while the education of the *master's programme Medical Engineering* mainly takes place in a clinical environment. Both Master's programmes interact with relevant companies and international institutes.

Bachelor's programme Biomedical Engineering

Standard 1: Intended learning outcomes
The *bachelor's programme Biomedical Engineering* intends to offer students a thorough, broad and up to date education in the field of biomedical engineering. According to the committee, the programme has a clear mission and clear goals.

The universities in the Netherlands offering degree programmes biomedical engineering agreed upon domain specific requirements. These domain specific requirements are elaborated into 26 specific intended learning outcomes for the TU/e *bachelor's programme Biomedical Engineering,* clustered in six categories. According to the committee, these intended learning outcomes are in line with the domain-specific requirements. However, the intended learning outcomes do not explicitly reflect the orientation and the focus of the tracks of the programme.

Since September 2012, the bachelor's programme offers two majors: *Medical Sciences and Engineering* and *Biomedical Engineering.* Half of the bachelor's programme focuses on one of the two majors. While students in *Medical Sciences and Engineering* are specializing in biomedical subjects such as methods for diagnosis and intervention, the students in *Biomedical Engineering* will focus more on technological subjects like mechanics, physics and materials. The committee is of the opinion that the focus of the two majors should be better reflected in the intended learning outcomes.

Standard 2: Teaching-learning environment
The three year bachelor's programme is offered as a full-time and part-time programme of 180 EC. Based on its didactical concept, the programme offers a mixture of courses (lectures, 60%) and Design Centred Learning (DCL, 40%). DCL consists of cases and training sessions, not only for application (practicals, experiments) and integration of engineering, sciences and

the life sciences, but also for acquiring typical (biomedical) engineering skills as working in groups, communication, being aware of ethical issues, etcetera. The teaching-learning concept that structures the programme is in the view of the committee very good and supportive for the learning process of the students. Within the programme, several essential skills are trained. However, the committee was missing a clear overview of the coherence and could not see how the skills build up within the programme.

Each year of the full-time programme consists of two semesters and four quartiles of ten weeks each. Each quartile contains three courses in engineering and life sciences and one DCL case. In the first semester of the third year, students may choose a minor. Within the scope of biomedical engineering, at the moment two minors are offered: *Biomedical Engineering* and *Biomedical Instrumentation Engineering*; the latter is a collaborative programme with the department of Electrical Engineering. The second semester is again devoted to the biomedical engineering major and is concluded with a graduation project.

In September 2012, the programme gradually started implementing a new curriculum for the bachelor's programme. Half of the bachelor's programme focuses on one of the two new majors *Medical Sciences and Engineering* and the major *Biomedical Engineering*. At the end of year one students can still switch between the two tracks. While students in *Medical Sciences and Engineering* are specializing in biomedical subjects like diagnosis & intervention and exchange & regulation, the students in *Biomedical Engineering* will focus more on technological subjects like mechanics, physics and materials. The new programme is more tailored to the student's career interests. Amongst other expectations, it is believed this new curriculum will improve student progress. The committee welcomes the idea of educating broad bachelor students, but advises the programme to ensure that all students get sufficient education in engineering.

According to the committee, the content and structure of the bachelor's programme enable the admitted students to achieve the intended learning outcomes. The courses comprise basic knowledge in all fields related to biomedical engineering. It is clear to the committee that the bachelor's programme makes a choice for and focuses on biomedical research. However, the committee believes that some other disciplines are underexposed: designing, entrepreneurship, business culture, risk assessment and regulatory affairs, social competences and report writing need more attention.

The facilities are good and support the teaching-learning concept by enabling the students to work together on projects and assignments and to perform small scale research and design projects. The committee was impressed by the diversity, quality and flexibility of the experimental setups with which bachelor and master students can have excellent hands-on experience.

The teaching staff is involved in actual innovative research and is internationally well known. The staff background in biomedical engineering is very good. The staff is enthusiastic and supportive for the students.

Standard 3: Assessment and achieved learning outcomes

Exams are taken at the end of each quarter. For the courses, the traditional written exam is widely used. In a growing number of courses, the use of a notebook with some specific software programme is necessary. Exams are taken in the final two weeks of a quarter. The propaedeutic courses of the first quarter are also examined at midterm. Participation is not mandatory. The midterm exams help students to identify at an early stage their strengths and weaknesses. If a student passes this midterm exam, the final exam will only be about the

remainder of the course. The committee has established that the bachelor's programme has an adequate assessment systems and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of individual exams, the assessment procedures and graduation theses. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment.

The committee assessed fifteen recent bachelor theses and established that all theses met the requirements for graduation. On average, the theses are of sufficient quality. The committee did not read any thesis from the selection provided that on the whole was unsatisfactory. The theses are short (fifteen to twenty pages), but the depth of the theses is quite good, according to the committee. However, the committee was surprised to see that the chosen form of the theses can differ significantly. For example, one thesis was written as a literature review and a research proposal. The committee feels that a more standard guideline for writing a bachelor thesis is needed.

In the past years a common assessment form is used for the final assessment of bachelor and master students. The committee recommends to differentiate between bachelor and master level and to develop an assessment form specifically for each programme. Furthermore the committee strongly recommends that these assessments forms are filled in by all supervisors in a uniform way. The forms should be made available to and known by all staff members and students.

Bachelor's programme Biomedical Engineering :

Standard 1: Intended learning outcomes	**satisfactory**
Standard 2: Teaching-learning environment	**good**
Standard 3: Assessment and achieved learning outcomes	**satisfactory**
General conclusion	**satisfactory**

Master's programme Biomedical Engineering

Standard 1: Intended learning outcomes
The *master's programme Biomedical Engineering* aims at educating students with a bachelor's degree in Biomedical Engineering to become a researcher and to function as an engineer in a research and development environment related to medicine and healthcare. Three master tracks are distinguished: *Biomechanics & Tissue Engineering*, *Molecular Bioengineering & Molecular Imaging*, and *Biomedical Imaging & Modelling*. In September 2012, the new master track *Regenerative Medicine and Technology* started, in collaboration with the Master Biomedical Sciences at Utrecht University. The tracks coincide with the research divisions and are divided to give students a direction for choosing their electives and shaping their programme.

The committee believes that by distinguishing the master tracks, the programme makes a clear choice and focuses on biomedical research and development within the fields of expertise of the department. By staying close to the expertise available within the department, the programme ensures expert guidance and presence of state-of-the-art equipment.

The universities offering degree programmes biomedical engineering in the Netherlands agreed upon domain specific requirements. The programme makes use of these domain specific requirements. In addition, seven additional competences are described. According to the committee, the use of the domain specific requirements is sufficient. The committee believes these requirements are well described in terms orientation and that they differentiate sufficiently between the bachelor's and master's level. However, the seven additional competences of the programme are quite general and do not reflect specific orientation of the programme and their tracks.

Standard 2: Teaching-learning environment
The curriculum comprises a first year with ten elective courses and an internal and an external internship. Starting in 2011, the internal internship has been terminated; only an external internship (externship) is taken and one third of it may be chosen freely, after consultation with the graduation professor. This may be literature research, extra courses, a prolonged internship, an extra internship, etcetera. The second year consists of the graduation project concluded with the master's thesis. Students have the possibility to shape their master's programme according to their own individual wishes and interests. To ensure a well-balanced programme with sufficient depth and diversity, the complete set has to be approved by the graduation professor: a full professor.

The committee studied the curriculum of the master's programme and concludes that the programme offers students sufficient depth in the engineering field related to clinical practice. The courses enable the students to develop their competences in biomedical engineering on an advanced level and prepare the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in (bio)medical engineering is required. The master programme is interesting and challenging, according to the committee. It provides a good balance between experimental and theoretical research.

Students participate in research groups and are involved in innovative high level research projects. The committee is convinced that the students receive sufficient guidance and supervision during their internship and master thesis project.

Standard 3: Assessment and achieved learning outcomes
The elective courses are evaluated using written or oral exams or assignments. Grades are given by the responsible teacher. Grades of internships are given by the responsible staff member. In case of an externship, the presentation is given at both the receiving institute and the supervisor's lab; the grade of the report of the external (mostly foreign) supervisor is usually accepted by the graduation professor. The committee suggests the programme to develop an assessment form to grade the internships with verbalized grades on each of the criteria. The committee has established that the master's programme has an adequate assessment system and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The committee assessed fifteen recent master theses of the *master's programme Biomedical Engineering* and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. Several theses are graded even higher by the committee than by the programme. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment.

In the past years a common assessment form is used for the final assessment of bachelor and master students. The committee recommends to differentiate between bachelor and master level and to develop an assessment form specifically for each programme. Furthermore the committee strongly recommends that these assessments forms are filled in by all supervisors in a uniform way.

Master's programme Biomedical Engineering

Standard 1: Intended learning outcomes	**satisfactory**
Standard 2: Teaching-learning environment	**good**
Standard 3: Assessment and achieved learning outcomes	**satisfactory**
General conclusion	**satisfactory**

Master's programme Medical Engineering

Standard 1: Intended learning outcomes
It is expected from graduates of the *master's programme Medical Engineering* to work in or in close collaboration with medical teams and come in direct contact with patients. The programme prepares students for an engineering career in a clinical and/or industrial environment. Medical engineers will on one hand initiate application of research innovations in the clinical practice, and on the other hand, they will transfer clinical requests into specific research aims.

Three master tracks are distinguished, which coincide with the research divisions. The master tracks are *Biomechanics & Tissue Engineering, Molecular Bioengineering & Molecular Imaging,* and *Biomedical Imaging & Modelling.*

The universities offering degree programmes biomedical engineering in the Netherlands agreed upon domain specific requirements. The programme makes use of these domain specific requirements of biomedical engineering. The programme added four intended learning outcomes to the domain specific requirements to state the difference with the *master's programme Biomedical Engineering.* In addition, seven more competences as compared to the Master of Biomedical Engineering are described. According to the committee, the use of the domain specific requirements is sufficient. The committee believes these requirements are well described in terms of orientation and that they differentiate sufficiently between the bachelor's and master's level. However, the seven additional competences of the programme are quite general and do not reflect specific orientation of the programme and their tracks. Furthermore, the extra four intended learning outcomes for the *master's programme Medical Engineering* are quite basic. The committee is of the opinion that the domain-specific requirements need more elaboration.

Standard 2: Teaching-learning environment
The educational programme of the programme comprises a first year with eight elective courses, two clinical modules and an internship. Starting in 2011, the internal internship has been terminated; only an external internship (externship) is taken and one third may be

chosen freely, after consultation with the graduation professor. This may be literature research, extra courses, a prolonged internship, an extra internship, etcetera. The second year consists of the graduation project concluded with the master's thesis.

The committee studied the curriculum of the master's programme and concludes that the programme offers students sufficient depth in the engineering field related to clinical practice. The courses enable the students to develop their competences in medical engineering on an advanced level and prepare the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in (bio)medical engineering is required. The master's programme is interesting and challenging, according to the committee. It provides a good balance between research and theory.

Students have the possibility to shape their master's programme according to their own individual wishes and interests. To ensure a well-balanced programme with sufficient depth and diversity, the complete set has to be approved by the graduation professor.

Students participate in research departments and are involved in innovative high level research projects. The committee is convinced that the students receive sufficient guidance and supervision during their internship and master thesis project.

The committee advises to monitor closely the workload and study delay of students and investigate if any scheduling issues between locations be minimised .

Standard 3: Assessment and achieved learning outcomes
The elective courses are evaluated using written or oral exams or assignments. Grades are given by the responsible teacher. The grade of the internship is given by the responsible staff member. In case of an externship, the presentation is given at both the receiving institute and the mentor's lab; the grade of the report of the foreign mentor is usually accepted by the graduation professor. The committee suggests the programme to develop an assessment form to grade the internships with verbalized grades on each of the criteria.
The committee has established that the master's programme has an adequate assessment system and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment.

The committee assessed fifteen recent master theses of the *master's programme Medical Engineering* and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. Several theses are graded even higher by the committee than by the programme. The committee did not read theses from the selection provided that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme.

In the past years a common assessment form is used for the final assessment of bachelor and master students. The committee recommends to differentiate between bachelor and master level and to develop an assessment form specifically for each programme. Furthermore the committee strongly recommends that these assessments forms are filled in by all supervisors in a uniform way.

The committee established that the theses of both master's programmes do not differ much in nature. The theses of the *master's programme Medical Engineering* should be more embedded in clinical practice, but the committee didn't see that reflected in the theses. The committee advises the *master's programme Medical Engineering* to reflect the differences between the two graduation projects in the assessment criteria. In addition, they need to be reflected in the templates for the graduation project and the thesis' writing.

Master's programme Medical Engineering:

Standard 1: Intended learning outcomes	**satisfactory**
Standard 2: Teaching-learning environment	**good**
Standard 3: Assessment and achieved learning outcomes	**satisfactory**
General conclusion	**satisfactory**

The chair and the secretary of the committee hereby declare that all members of the committee have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 17-12-2012

Prof. dr. ir. J. Vander Sloten

drs. L. van der Grijspaarde

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

Findings

For this standard, a short introduction to the three programmes is given (1.1). After that, the domain specific requirements are described (1.2). In addition, the goal and intended learning outcomes of the programmes are described and discussed separately (1.3).

1.1 Introduction to the programmes

In September 1997, the Engineering education programme Biomedische Technologie (Biomedical Engineering) started at the TU/e in collaboration with the University of Maastricht. The initiation was inspired by the long-term collaboration in biomedical research between the two universities, which resulted in a research-oriented education programme. This programme was structured with a bachelor's and a master's phase from the onset but was still one programme culminating in the degree of Engineer in Biomedical Engineering.

The Biomedical Engineering education programme started as an activity of the Education Institute Biomedical Engineering TU/e (established within the Department of Mechanical Engineering in 1996), in collaboration with the University of Maastricht. In 1999, it was decided that Biomedical Engineering would become a real department to clarify its position between the other departments at TU/e. In September 2002, the bachelor-master structure was formally adopted. A three year Bachelor's degree in Biomedical Engineering was coupled to two different two year Master's degrees: *Biomedical Engineering* and *Medical Engineering*. The *master's programme Biomedical Engineering* is strongly research oriented, while the *master's programme Medical Engineering* combines the research orientation with clinical components. Therefore, *master's programme Biomedical Engineering* education almost completely takes place in the university environment, while *master's programme Medical Engineering* education mainly takes place in a clinical environment (mainly at the University of Maastricht). Both Master's programmes interact with relevant companies and international institutes.

1.2 Domain specific requirements

The objective of the *bachelor's programme* and the *master's programmes Biomedical Engineering* and *Medical Engineering* of the Eindhoven University is described in the domain statement. According to this domain statement, biomedical engineering is an interdisciplinary field, combining engineering disciplines and natural and life sciences. Integrating scientific and engineering concepts and methodology, the Biomedical Engineer works to increase scientific knowledge and solve health care problems, by:

1. acquiring new knowledge of living systems through continuous innovation and substantive application of experimental, analytical, and design techniques,

2. designing and developing new devices, algorithms, processes and systems to advance medical technology in health care,
3. solving health care problems through purposeful context-driven problem solving;
4. implementing solutions using excellent cross-disciplinary communication and cooperation skills.

In 2005, domain-specific requirements for biomedical engineering in the Netherlands were developed by the biomedical engineering programmes of the Eindhoven University of Technology, the University of Twente and the University of Groningen. Recently, the three original partners and the Technical University Delft confirmed these domain-specific requirements. The domain-specific requirements are presented in appendix 2. To define intended learning outcomes or competences, the *bachelor's programme Biomedical Engineering* and the *master's programmes Biomedical Engineering* and *Medical Engineering* made use of these domain-specific requirements. According to the committee, the domain-specific requirements are well described in terms orientation and that they differentiate sufficiently between the bachelor's and master's level.

1.3 Goals and intended learning outcomes of the programmes

The goals and intended learning outcomes are discussed separately for the three programmes.

Bachelor's programme Biomedical Engineering

For the *bachelor's programme Biomedical Engineering*, in total 26 intended learning outcomes are presented in the self-evaluation report, clustered in six categories: knowledge and understanding; applying knowledge and understanding; communicating and functioning in a team; reflecting on social, academic and ethical issues; learning skills; and design skills (appendix 3).

The committee is of the opinion that the intended learning outcomes are well described in terms of level and orientation and are in line with the domain-specific requirements for biomedical engineering. However, the committee thinks that the intended learning outcomes are not as explicit as they should be. As becomes clear from the described goal of the bachelor's programme and is shown by the curriculum, the bachelor's programme does take a clear position within the domain of biomedical engineering. The intended learning outcomes do not explicitly reflect this orientation of the programme.

Since September 2012, the bachelor's programme offers two majors: *Medical Sciences and Engineering* and *Biomedical Engineering*. Half of the bachelor's programme focuses on one of the two majors. While students in *Medical Sciences and Engineering* are specializing in biomedical subjects like diagnosis & intervention and exchange & regulation, the students in *Biomedical Engineering* will focus more on technological subjects like mechanics, physics and materials. The committee is of the opinion that the focus of the two majors should be reflected in the intended learning outcomes. In the meeting with the committee, the programme management stated that since both majors are part of the same bachelor's programme, one set of intended learning outcomes should be sufficient. The committee agrees with the programme management, but is of the opinion that a subset of intended learning outcomes for both majors should make the intentions of the two majors more clear. In addition, this will make it possible to describe more specific how the different curricula of the two majors meet the intended learning outcomes.

The committee would like to make a remark on the way the new major *Medical Science and Technology* is presented to incoming students in brochures and on the website. The committee

believes the brochure focuses too much on the medical part of the programme and not enough on the engineering part. For example, the statement at the front of the brochure 'I dream of an innovative and effective cure for cancer' may give the wrong impression on the engineering part of the programme. The committee was told by the programme management that it is difficult to make clear to incoming students that biomedical engineering really is an engineering programme, unlike for example the *bachelor's programme Technical Medicine* ('Technische Geneeskunde'). This was confirmed by some of the students the committee spoke with. They said that they thought the programme would be more chemistry and less electrical engineering and computing. According to the committee, a more clear provision of information about the programme to incoming students is very essential.

Master's programme Biomedical Engineering
According to the self-evaluation report, the *master's programme Biomedical Engineering* aims at educating students with a bachelor's degree in Biomedical Engineering (or an equivalent degree that allows successful completion of a specific master's track) to become a researcher and to function as an engineer in a research and development environment related to medicine and healthcare. Three master tracks are distinguished, which coincide with the research divisions. The master tracks are *Biomechanics & Tissue Engineering*, *Molecular Bioengineering & Molecular Imaging*, and *Biomedical Imaging & Modelling*.

The goals of the *master's programme Biomedical Engineering* are:

- Specialisation in a branch of Biomedical Engineering: The selected courses, internships and graduation project provide the opportunity to the student to acquire the specialist knowledge of a specific area of Biomedical Engineering. Acquired knowledge is not only applicable to the specific field, but serves as a pedestal and can easily be applied in many other domains.
- Work in a multidisciplinary team.
- Independent scientific practise.
- During the internships and graduation project, participate in a design experience.
- Students have their design experience in the internships and the graduation project.
- Awareness of ethical and socio/economic aspects of Biomedical Engineering and societal responsibility as engineer.

Three master tracks are distinguished: *Biomechanics & Tissue Engineering*, *Molecular Bioengineering & Molecular Imaging*, and *Biomedical Imaging & Modelling*. In September 2012, the new master track *Regenerative Medicine and Technology* started, in collaboration with the Master Biomedical Sciences at Utrecht University. Researchers at both universities realised that they needed this track, which may develop into a joint master's programme, in order to prepare students for research in the rapidly developing field of regenerative medicine. The master tracks coincide with the research divisions and are divided to give students a direction for choosing their electives and shaping their programme.

For the *master's programme Biomedical Engineering*, apart from the domain-specific requirements, six additional goals are described:

- Specialisation in a branch of Biomedical Engineering: The selected courses, internships and graduation project provide the opportunity to the student to acquire the specialist knowledge of a specific area of Biomedical Engineering. Acquired knowledge is not only applicable to the specific field, but serves as a pedestal and can easily be applied in many other domains.
- Work in a multidisciplinary team.

- Independent scientific practise.
- During the internships and graduation project, participate in a design experience.
- Students have their design experience in the internships and the graduation project.
- Awareness of ethical and socio/economical aspects of BME and societal responsibility as engineer.

The committee believes that by distinguishing the three master tracks, the programme makes a clear choice and focuses on biomedical research and development within the fields of expertise of the department. By staying close to the expertise available within the department, the programme ensures expert guidance and presence of state-of-the-art equipment.

The programme uses the domain-specific requirements and six additional goals as their intended learning outcomes. According to the committee, this is sufficient.

Master's programme Medical Engineering
According to the self-evaluation report, in contrary to biomedical engineers, it is expected from graduates of the *master's programme Medical Engineering* to work in or in close collaboration with medical teams and come in direct contact with patients. The programme prepares students for an engineering career in a clinical and/or industrial environment. Medical engineers will work together with medical specialists on the application of advanced technologies and interpretation of their results, and thus aid doctors with the establishment of diagnosis, treatment, and surgical schemes. In addition, medical engineers can act as links between the clinic, academic research and development and industry. As such, medical engineers will on one hand initiate application of research innovations in the clinical practice, and on the other hand, they will transfer clinical requests into research aims.

Three master tracks are distinguished: *Biomechanics & Tissue Engineering*; *Molecular Bioengineering & Molecular Imaging*; and *Biomedical Imaging & Modelling*. These are the same master tracks as distinguished in the other master's programme and coincide with the research divisions. They are divided to give students a direction for choosing their electives and shaping their programme.

The programme offers students:
- more depth in one of the specialisations of Medical Engineering;
- working in multidisciplinary team;
- independent research;
- a (clinical) designing experience;
- interaction with clinicians and individual patients;
- awareness of ethical and socio/economical aspects of ME and societal responsibility (as engineer).

The programme uses the domain-specific requirements as their intended learning outcomes. The programme added four intended learning outcomes to the domain specific requirements to state the difference with the *master's programme Biomedical Engineering* (see asterisks *, appendix 3).

According to the committee, it is sufficient to use the domain-specific requirements as their intended learning outcomes. However, the extra four intended learning outcomes (in asterisks) are very basic. If the asterisks are the only difference, there is no sufficient difference between both programmes and there would be no motivation for an separate

programme, according to the committee. The programme management explained clearly to the committee that there is a difference, but the committee does not see this reflected in the learning outcomes. The difference between both programmes may not be perceived by outsiders.

Considerations

The committee established that the bachelor programme intends to offer students a thorough, broad and up to date education in the field of biomedical engineering. The master programmes offer the students the possibility to obtain thorough knowledge, insight and skills in Biomedical and Medical Engineering, and in one of three master tracks. All three programmes have a clear mission and clear goals.
The committee believes that by distinguishing the three master tracks, the master programmes make a clear choice and focuses on biomedical research and development within the fields of expertise of the department. By staying close to the expertise available within the department, the programmes ensure expert guidance and presence of state-of-the-art equipment.

The programmes make use of the domain specific requirements of biomedical engineering. The committee is of the opinion that these are well described in terms orientation and that they differentiate sufficiently between the bachelor's and master's level.

The domain specific requirements are elaborated into 26 specific intended learning outcomes for the *bachelor's programme Biomedical Engineering* . According to the committee, these intended learning outcomes are in line with the domain-specific requirements. However, the intended learning outcomes do not explicitly reflect the orientation and the focus of the tracks of the programme.

The *master's programme Medical Engineering* added four intended learning outcomes to the domain specific requirements to state the difference with the *master's programme Biomedical Engineering.* According to the committee, the use of the domain specific requirements is sufficient. However, the seven additional competences of the programme are quite general and do not reflect specific orientation of the programme and their tracks. In addition, the extra four intended learning outcomes for the *master's programme Medical Engineering* are quite basic. The domain-specific requirements could be elaborated more.

Conclusion

Bachelor's programme Biomedical Engineering : the committee assesses Standard 1 as **satisfactory**.
Master's programme Biomedical Engineering: the committee assesses Standard 1 as **satisfactory**.
Master's programme Medical Engineering: the committee assesses Standard 1 as **satisfactory**.

Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Findings

The contents (2.1), the learning environment (2.2), the quantity and quality of the staff (2.3) and the facilities (2.4) of the *bachelor's programme Biomedical Engineering* , of the *master's programme Biomedical Engineering* and of the *master's programme Medical Engineering* are discussed below.

2.1 Contents of the programme

The contents of the bachelor's and of the master's programmes are described and discussed separately. In addition, the correspondence between the intended learning outcomes and the programmes has been discussed.

2.1.1 Curriculum of the bachelor's programme Biomedical Engineering

The three year bachelor's programme is offered as a full-time and part-time programme of 180 EC.

The programme management explained to the committee that the possibility for part-time studying is not recommended and hardly used. Because of this, the committee did not have the possibility to speak with part-time students. However, the committee believes that the few students that enrol for this, are given a sufficient and tailored programme at the discretion of the programme director .Especially if students taking the course part-time are working in the biomedical industrial sector, this would tie the programme closer to the industrial needs.

In September 2012, the (full-time) programme gradually started implementing a new curriculum for the bachelor's programme. In the year 2012-2013, the programme offers the first year of the new curriculum. The committee spoke with students who are now in the first year of the new curriculum. In addition, the committee spoke with second year students and older students who follow(ed) the old bachelor's curriculum.

The old and the new curriculum are discussed below.

Old curriculum

Appendix 4 provides an overview of the old curriculum (2011-2012).

Each year of the full-time programme consists of two semesters and four quartiles of ten weeks each. Each quartile contains three courses in engineering and life sciences (3 EC each) and one case (6 EC; cases are explained in the section on the didactical concept). Within the first quartile, two cases of 3 EC each are programmed, to make the students acquainted with working with cases. In the first semester of the third year, students may choose a minor within the department or within another department. Within the scope of biomedical engineering, at the moment two minors are offered: *Biomedical Engineering* and *Biomedical Instrumentation Engineering*; the latter is a collaborative programme with the department of Electrical Engineering. A minor consists of five courses (3 EC each), Academic Education (3

EC) and two projects (6 EC each). The second semester is again devoted to the biomedical engineering major and is concluded with a graduation project.

The previous Accreditation Committee indicated in 2006 that the education programme required strengthening in the fields of statistics, signal analysis, imaging and designing. The study load of statistics was doubled, more imaging courses were introduced, With the focus on topics of the research divisions, the programme made the choice not to include more signal analysis.

In order to inform the students about the research at the department, Science Classes are introduced, presented in the first year by full professors giving an overview of biomedical engineering in their respective areas. In the second year, other lecturers give presentations on specific extracurricular topics.

The committee studied the content of the curriculum and concludes that all relevant aspects are included. The courses comprise basic knowledge in all fields related to biomedical engineering: mathematics, the sciences, and life sciences. Integration of the various disciplines (including life sciences) occurs whenever possible and appropriate. It is clear to the committee that the bachelor's programme makes a choice for and focuses on biomedical research, for example by the Science Classes. The committee welcomes the programme to have a clear focus, but thinks that, however, some other disciplines could get more attention. Firstly, the committee feels there could be more emphasis on engineering design in the programme. The programme management told the committee it is assured that the amount of education on designing will be increased in the new curriculum. Secondly, students reported to the committee that, probably because of the focus on research, less focus is on entrepreneurship, business culture and on the working environment in engineering. In addition, according to the committee, some introduction and overview of risk assessment and regulatory affairs should be introduced in the bachelor's programme. The committee suggests to build in more cases with aspects of and focus on entrepreneurship, for example cases from a hospital or from industry. Another aspect which could be elaborated in the bachelor's programme, is the attention to social competences and reporting in writing.

According to the self-evaluation report, it is found important that the lecturers are familiar with the contents of prior courses and cases. Therefore, the programme created the Curriculum Information Centre, where teaching material of all lectures and cases and the exam requirements are collected and readily available to the teaching staff. This gives each lecturer easy access to all material and a good possibility to study the material of prior courses. During the interview with the committee, the students confirmed that the bachelor curriculum is structured in a cohesive and satisfying way. Learning outcomes and competences to be achieved by the students in the courses are built on what was learned previously. There is, according to the students, no dysfunctional overlapping.

New curriculum

Appendix 4 provides an overview of the new curriculum (2012-2013).

In June 2011, TU/e embarked on a radical reform of its bachelor education. TU/e is achieving this by developing the ' TU/e Bachelor College'. The goal of the Bachelor College is to make the programmes more attractive, challenging and feasible for all science students, whether they are generalists or have a focus on science, people or a career. In addition, the university strives for higher student numbers and improved graduation rates. With effect from September 2012, TU/e Bachelor College is bringing together all the Bachelor programs

under one umbrella. Within the TU/e Bachelor College, every program will have four components: a major worth 90 EC; a basic worth 30 EC; a USE component worth 15 EC (USE stands for User, Society and Entrepreneurial perspective) and electives worth 45 EC. According to the self-evaluation report, this structure will mean that all students will study people and society subjects, thus enabling them to place their chosen discipline in its civic and human context. In addition, they have a broad scope for electives. The departments are making an effort to offer appealing elective combinations (disciplinary and interdisciplinary) relating to challenging themes. Students can use the electives to study their own discipline in greater depth or, alternatively, to broaden their learning. They can steer their program and professional development in the direction of their own choice. They have the opportunity to combine various disciplines offered by different departments.

Each year of the new full-time *bachelor's programme Biomedical Engineering* consists of two semesters and four quartiles. Each quartile contains two courses in engineering and life sciences (5 EC each) and one case (5 EC). In the past, the choice has been made for engineering as the core of the education of the programme. According to the self-evaluation report, the biomedical part could be strengthened. The new bachelor's programme therefore will offer two majors: *Medical Sciences and Engineering* and the major *Biomedical Engineering* (see also standard 1). Half of the bachelor's programme focuses on one of the two majors. At the end of year one students can still switch between the two tracks. While students in *Medical Sciences and Engineering* are specializing in biomedical subjects like diagnosis & intervention and exchange & regulation, the students in *Biomedical Engineering* will focus more on technological subjects like mechanics, physics and materials.

During the meeting with the programme management, the committee discussed the differences of the new bachelor's programme compared to the old programme. The programme management explained that the new bachelor's programme is more tailored to the students. Students will be able to compile their own programme, under supervision of staff members. More diversity in the bachelor's programme is expected. First year students confirmed to the committee that they now have a broad spectrum of possibilities. They are positive about the variety in courses. They are pleased that it is 'not all engineering'. The committee welcomes the idea of educating broad bachelor students, but advises the programme to ensure that all students get enough education on engineering.

According to the self-evaluation report, many students have difficulties with the mathematics courses. The programme introduced a connection programme for mathematics. In addition, within the new programme, only one mathematics course is offered in the first year. The other old first year courses are switched to the second year. This will motivate students better, according to the programme management. During the interview with the programme management, the committee suggested to use and introduce mathematics within courses when it is needed Mathematics concepts can be introduced in courses such as biomedical signal processing, image analysis, gait analysis etc. The programme management thinks this is an interesting idea, but explains that integration with other disciplines is not possible at the moment, because mathematics is offered by the mathematical department. However, the teaching staff from the mathematics department is capable of implementing assignments taken from the biomedical area.

The committee heard from second and third year bachelor students that the transition from the old to the new curriculum makes it more difficult to redo courses of the first year. It is not always clear to them what and how courses are offered. According to the students, they

need to contact individual teachers to obtain information. The committee asks attention of the programme management to ensure a smooth transition.

2.1.2 Curriculum of the master's programme Biomedical Engineering
The educational programme of the programme comprises a first year with ten elective courses (30 EC) and an internal and an external internship. At least two of the ten elective courses have to be from another division (track) than the chosen one. Starting in 2011, the internal internship has been terminated; only an external internship (externship) of 21 EC is taken and 9 EC may be chosen freely, after consultation with the graduation professor. This may be literature research, extra courses, a prolonged internship, an extra internship, etcetera. The second year consists of the graduation project concluded with the Master's thesis (60 EC). Appendix 4 provides an overview of the curriculum of the *master's programme Biomedical Engineering.*

The curriculum may be officially entered in September or February. However, since students may achieve the requirements to enter the programme during the entire year, individual students may in practice start at any time of the year, upon availability of courses and projects. As of September 2012, students may only enter the master's phase after completion of their bachelor's programme.

Students select their own programme. To ensure a well-balanced programme with sufficient depth and diversity, the complete set has to be approved by the graduation professor: a full professor. Part-time professors may also act as graduation professor in consultation with their affiliated biomedical engineering full professor. According to the self-evaluation report, elective courses introduce a student to the research area of the research group involved, give insight into the state of the art of that research area and prepares for the research of the internship, externship and graduation project. All elective courses are given by experts in the field. Altogether, they cover the whole width of the Biomedical Engineering research area at Eindhoven University of Technology.

The committee studied the curriculum and concludes that the programme offers students sufficient depth in the engineering field.

2.1.3 Curriculum of the master's programme Medical Engineering
The educational programme of the *master's programme Medical Engineering* comprises a first year with eight elective courses (24 EC) combined with two clinical modules of their choice (16 EC) and a clinical internship (20 EC). A clinical module is a project oriented education module where students take part in the pre-diagnostic, the diagnostic and the intervention phase of patient care with a certain clinical picture. In the second year, students do their graduation project (60 EC). Appendix 4 provides an overview of the curriculum of the *master's programme Medical Engineering.*

The first year is divided in two semesters and four quartiles of ten weeks each. This programme allows flexibility with entrance of the curriculum; students may enter the programme at two instants per year starting in 2012.

Each clinical module aims at providing insight into several aspects of a medical specialisation. A clinical module consists of 3 phases: 50 hours of prediagnostic phase (18.5 hours courses; 20 contact hours), 50 hours of diagnostic phase (10 contact hours), and 125 hours of intervention phase (20 contact hours). Two clinical modules must be selected from the following four: Oncology, Cardiovascular Diseases, Neurology and Orthopaedics. The

philosophy for selection of these clinical modules was that each clinical field has a strong input from technology and, hence, is important for medical engineering and, inversely, medical engineering is important for them. In Neurology, signals play a dominant role. In Cardiovascular Diseases and orthopaedics, biomechanics and modelling are important support disciplines. All three modules have a good interaction with research at the department. This is not the case with Oncology, which, however, has a strong interaction with Radiotherapy (a key technology driven department) and has therefore been selected as a fourth topic for clinical module.

Internships are preferably carried out in a clinical setting, i.e., hospitals in the Netherlands or abroad and supervised by a member of the staff in collaboration with a clinician or technology professional at the hosting site. In general, the internship prepares for the graduation project and for the first time demands skills in organising a project, independently conducting of research, and writing scientific reports. In special cases the internship can also be carried out in industry or at non-clinical (university) sites provided that the graduation project is clearly clinically oriented. The final report may be submitted as a scientific paper or internal report.

The committee studied the curriculum of the programme and concludes that the programme offers students sufficient depth in the engineering field related to clinical practice with emphasis on cardiovascular diseases, oncology, neurology, and orthopaedics.

2.1.4 Correspondence between intended learning outcomes and the curricula

The committee studied the programmes of the old and the new bachelor's programme and of the master's programme and concludes that the three programmes offer students the possibilities to achieve the necessary knowledge and skills. The intended learning outcomes (competences) of the programme are translated per course into specific learning objectives.

For the *bachelor's programme Biomedical Engineering,* an overview is presented in which for each course the required prior courses are indicated. In addition, the relationship between the categories of the intended learning outcomes and the courses and cases is presented in a matrix. However, the committee was missing a more detailed overview of the correspondence between the 26 intended learning outcomes and the (elements of the) curriculum. It is not made clear how the learning objectives per course meet the intended learning outcomes. For example, how and where is assessed if a bachelor student is able to integrate existing knowledge in a design? The committee is of the opinion that the coverage of the intended learning outcomes has to be proven by linking them to the specific learning objectives of the various elements in the programme.

As discussed in the previous paragraph, within both master programmes, students are able to compile their programme by choosing courses from a preselected list. The course list needs to be approved by a full professor. Within the self-evaluation report, the programmes refer to the seven items of the domain specific requirements and claim they are included in the elective courses, the various internships and in the graduation project. The committee has some doubts if it can be assured that the intended learning outcomes will be obtained by all master students.

2.2 Learning environment

The learning environments of the bachelor's programme and of the master's programmes are described separately.

2.2.1 Learning environment of the bachelor's programme Biomedical Engineering

For the learning environment, the didactical concept, the study load, study duration, and the dropouts are discussed. In addition, the tutoring and study advice, the honours programmes and the admission requirements are treated.

Didactical concept

Based on its didactical concept, the programme offers a mixture of courses (lectures, 60%) and Design Centred Learning (DCL, 40%). The main characteristic of DCL is to integrate knowledge acquired in prior courses with some additional knowledge required to complete the case. DCL consists of cases and training sessions, not only for application (practicals, experiments) and integration of engineering, sciences and the life sciences, but also for acquiring typical (biomedical) engineering skills as working in groups, communication, being aware of ethical issues, etcetera. DCL aims at application of knowledge from various disciplines (usually from courses presented in the preceding semesters) to solve problems pertinent to the field of biomedical engineering. Solving the (biomedical) problems requires thorough understanding of the topic and the capability to combine and integrate prior knowledge.

During the bachelor's programme, the goals shift from the process of how to get to a solution (the cases) towards the actual result (the projects). Parallel to this shift, the number of students per group is reduced from eight in the first year, to four in the second year and two and one, respectively, during the minor and major projects.

The students who the committee spoke with, were enthusiastic about the DCL. They like working in a team at multidisciplinary projects. The teams are formed randomly, every project is done with a different group of people. According to the students, they receive multiple trainings on how to work together, assess themselves and others. Free riding by students ('meeliften') is countered by assessing the students group work individually as well and by involving the group itself in the grading, in a progressive manner.

Each course offers students support to apply the acquired knowledge; problems are being solved in guided self-study sessions where the lecturer(s) and assistants are available to discuss the remaining obstacles and elaborate on the prior taught material to improve the level of understanding. Students work in small groups, but are also expected to study independently at home. According to the self-evaluation report, this cycle of lecture, guided self-study, and self-study allows students to digest the material properly. Acquiring knowledge mainly occurs in the courses.

In DCL and the lab practicals, students have to apply knowledge, gather data, and interpret data. They learn skills specifically related to the field of biomedical engineering.

The committee concludes that there is a nice mix of teaching forms available. The combination of courses and DCL provides students with the opportunity to learn in a varying environment. Within the programme, several essential skills are trained. However, the committee missed a clear overview of the coherence of the skill training and could not see how the skills are built up within the programme. The committee also established that the link between the content of the courses and the cases of the DCL is not always clear to the students. The committee thinks that the link between courses and DCL even may become more unclear in the new Bachelor College, with more freedom of choice for the students. The committee recommends to make a clear overview of the coherence of knowledge and skills in the programme.

Study load, study duration and dropouts

A standard week in the first year consists of three courses of four hours lecturing and two hours guided self-study and a DCL case with two meetings of two hours. This results in at least 22 contact hours with education staff. Moreover, some special training activity may occur. The remainder of the week should be devoted to non-guided self-study. During the projects of the third year, at least four contact hours per week with education staff (including the PhD students with whom they work) is scheduled.

The total student workload for a course is 84 hours, consisting of 28 hours of lectures, 14 hours of guided self-study and 42 hours for personal self-study and the exam. The DCL-cases are rewarded with 6 EC. In a period of seven weeks, the students work 14 times two hours in groups. The remainder is devoted to experiments, self-study and reporting of the results.

Students reported to the committee that they feel the study load is quite high, but acceptable. They spend on average thirty to forty hours per week at their studies.

According to the self-evaluation report, the graduation rates of the bachelor's programme are too low. 40% of the students drop out in the first year and most students take much longer to complete their bachelor's degree than the nominal three years. Only 35% of students who re-enrol after the first year, achieve a diploma within four years of starting their programme. In the coming years, the programme wishes to grow towards a situation in which the drop-out rate in the first year is substantially reduced and that at least 70% of re-enrollers, after the first year, successfully complete their bachelor's programme within four years of starting it. In order to achieve this, all units of study (subjects and projects) will be worth 5 EC or a multiple of 5 EC and within each quarter, a maximum of three units of study will be offered in parallel. More student-activating forms of work will be used and it will be possible to average test results within units of study. A maximum of 70% of the final grade will be determined by the final exam. In addition, intake interviews will be held with all students who apply, and student coaching will be considerably intensified (discussed in the session on tutoring and study advice).

The committee discussed the planned graduation rate of 70% in four years, without lowering the standards, with the programme management. The committee believes that once the described measures have become fully effective, there will be a further decrease of the study duration and increase of the bachelor performance rate after four years. In addition, the committee discussed the strategy from the management to increase student numbers with their new international programmes. The committee trusts that the management maintains the quality of teaching standards while recognising the need to increase the student numbers. There is a demand for more graduates in these areas.

Tutoring and study advice

The study adviser monitors the study progress of all bachelor students. At the start of the second quartile of the first year, she invites those students who perform below expectation for an interview to discuss their progress and find the reasons for the underachievement. At the start of the second semester, students receive a pre-advice based on the results of the first half year. At the end of the first year, she sends a written report to all students with a binding advice about continuation or cessation of their study.

During the first semester of the propaedeutic year, each group of eight students is also supported by a student mentor, being a senior student who already guided this group during

their introduction period before the start of classes. This so-called P-mentor advises students about study habits and techniques, and can direct students to the study adviser when necessary. This allows for easier integration into the departmental community.

In case the study adviser feels that the student has made a wrong choice with the bachelor's programme, she will advise about alternative education options. If students are confronted with a delay in their study progress, they may approach the study adviser for an adapted study plan, adapted examination or other extra facilities. If necessary, the study adviser will refer the student to specialists, such as for instance a student psychologist.

During the meeting with the study adviser, the committee discussed on how to approach students who start studying with a wrong perception of the programme. The study adviser explained that in 2012 for the first time, start meetings with groups of incoming students were held in June and August. These meetings were to inform them on what the bachelor's programme is about. Students need to fill in a survey about their motivation. In addition, the students talk to their mentor twice in the first quartile, to help them make choices in the new Bachelor College. Students reported to the committee that they feel well guided and monitored in a structured way. They know where to go when they need support. The committee is enthusiastic about the active role of the study adviser, the student mentors and the start meetings. However, the committee recommends to continue efforts in informing incoming students correctly on the content and focus of the programme. As said before, the brochure on the new bachelor track Medical Science and Technology may give the wrong impression on the engineering part of the programme.

Honours programmes

In 2006, TU/e started a programme specially developed for students who want and can do more than the regular programme: the Honours Horizon programme. This programme is more in-depth and interdisciplinary. This programme is on top of the regular programme and takes about 10 hours per week.

Since September 2010, TU/e offers another in-depth programme: the Honours Stars programme. This programme is meant for students that want more in-depth studies in their own discipline, in our case Biomedical Engineering. The Honours Star programme is part of the regular Biomedical Engineering education programme and requires no extra time. Preferably students participate in both Honours programmes.

The committee thinks that the possibilities for top students who are interested in additional study challenges are adequate.

2.2.2 Learning environment of the master's programme Biomedical Engineering

For the learning environment of the master's programme, the didactical concept, the study load, the study duration, the tutoring, the study advice and the admission requirements are discussed.

Didactical concept

A semester is divided into two quartiles of ten weeks. The last two weeks are for exams. Before starting the graduation project, the bachelor's degree (as of September 2012 a condition sine qua non to enter the master's phase) must have been obtained.

As discussed above, in the master's programme, students work individually. They select elective courses that suit their field of specialisation in accordance with their thesis mentor

(graduation professor). Furthermore, they do one or more internships (one obligatory outside the university and preferably abroad) and their thesis work.

Study load and study duration

Given the fact that students may enter the master phase at two instants during the academic year, a standard study week is difficult to define. Electives are preferentially not scheduled on Wednesday allowing planning of activities with other students on that day. Depending on the choices made, elective courses can be taken at any time during the year. With a total of ten electives, this leaves enough time for the Free Education Space, which is individual, and by definition on a part-time basis. The externship should be done on a full-time basis and is outside of the university.

Each elective course yields 3 EC. The free education space is worth 9 EC. According to the self-evaluation report, this can easily be combined with six electives in the first semester. Time investment of an externship is scheduled for about 600 hours (21 EC). During this period combination with courses is virtually impossible. If electives are spread differently, this will not interfere with the externship, since it can be scheduled individually. Externship and the full time graduation project may be done throughout the year and do not necessarily follow the academic agenda.

The committee is of the opinion that there are no main concerns on the study load and study duration. It may happen that, in individual cases, parts of the programme happen to be difficult to organize but the committee doesn't feel this is a general point of concern.

Tutoring and study advice

In the third bachelor year, students receive advice about the various master tracks and specialisation. They will use this information in selecting those projects that they feel will be advantageous to select their track or to prepare them for a track. However, some bachelor students reported to the committee that they felt insufficiently prepared for making a argumented choice.

The committee welcomes the introduction of mentors at the start of the master's phase. Students at the end of the bachelor's phase get individual advice from the scientific staff about the best way to structure their Master's programme. In addition, the committee advises to expand the attention within the bachelor's phase on the possibilities in the master's phase.

Admission requirements

Students entering the master's programme all have a (almost) completed bachelor's degree in Biomedical Engineering of the department Biomedical Engineering. Direct access to the Master's programme is also possible with a bachelor Biomedical Engineering of the University of Twente or Life Science & Technology from the Delft University of Technology. Several other bachelor degrees allow access after a so-called deficiency programme of maximally 30 EC has been successfully completed within one study year.

Students from other universities or from a university of applied sciences (HBO) who apply for admittance to the BME Master's programme are screened by the programme committee BEST/e, chaired by the Director of Education. They will be advised about direct admittance or placement in a deficiency programme

The committee studied the admission requirements and believes they are clear for each group of enrolling students.

2.2.3 Learning environment of the master's programme Medical Engineering

For the learning environment of the master's programme, the didactical concept, the study load, the study duration, the tutoring, the study advice and the admission requirements are discussed.

Didactical concept

As described above, the first year of the programme consists of elective courses combined with two clinical modules of their choice and a clinical internship. Clinical modules are preferentially executed by duos. Prior to the start of a quartile, students sign up for a specific clinical module. Duos are formed that execute the complete clinical module together. At the start of each quartile, a meeting is held with the coordinators of the clinical module for planning of the clinical module, including assignments, agenda of demonstrations, and contents of the project. A clinical module contains several forms of education:

- Prediagnostic phase:
  Lectures: each clinical module contains a number of compulsory lectures by medical specialists and co-workers of the Academic Hospital in Maastricht. These lectures will be given in the first quartile and repeated in the second quartile. Students will report on the contents of the lectures in the introduction of their final report, where they describe the problem definition of their project that is partly based on the contents of the lecture (or vice versa). In case a clinical module is taken in the third quartile, the lectures have to be taken in the first or second quartile.
- Diagnostic phase:
  Assignments: Each clinical module comprises a number of assignments. They aim at acquiring skills in the most important theoretical and technological aspects of diagnostic and intervention techniques. Assignments are done under supervision and graded by the supervisors. Students are responsible for obtaining the assignments and for timely execution. Students are also responsible for planning of the meetings with supervisors. Reporting format is decided by the supervisors.
- All phases:
  Demonstrations: To obtain a good insight into clinical practise and the possibilities of a more technical approach as chosen in the project, students take part in patient discussions, patient visits, diagnostic meetings and operations. The clinical module coordinator decides which demonstrations will be attended. General arrangements with the clinical departments about demonstrations are made by the coordinator. Students are responsible for the final arrangements to be made.
- Intervention phase:
  Project: This is the core activity of each clinical module. The project combines all aspects of the clinical module. The pre-diagnostic, the diagnostic and the intervention phases are viewed with the eye of an engineer through modelling of the clinical picture, diagnostic equipment, data analysis and quantification, and clinical intervention. These projects may be mentored by personnel that mentors internships and graduation projects, but has to be executed in the framework of the clinical module.
- Final report:
  The project is concluded with a report in the form of a scientific paper or internal report.

The committee studied the didactic concept and concludes this is sufficient.

Study load and study duration

A standard week of the four quartiles (two semesters) of the first year comprises four courses (3 EC each), the scheduled meetings of the clinical modules (8 EC each), and ample time for

self-study. The actual times at which courses and clinical module are given varies over the quartiles.

Courses and modules have to be taken at the scheduled times, but internships and graduation projects may start at any time and allow for attending several courses. Internship and the full time graduation project may be done throughout the year and do not necessarily follow the academic agenda.

(Elective) Courses are planned in clusters in either Eindhoven or Maastricht to avoid unnecessary travel. Clinical modules take place in Maastricht. According to the self-evaluation report, if other activities are scheduled for that day, they will be in Maastricht. However, students reported to the committee that, despite the cluster planning, their study scheme usually does not fit in the regular study schemes as presented, which causes delay. It occurs that they are not able to attend courses because they need to attend the mandatory clinical courses. These students need to work extra in their free time to make up for the things they have missed. The committee advises to closely monitor the workload and study delay of students and remove schedule problems.

Tutoring and study advice
The comments on tutoring and study advice in the section on the *master's programme Biomedical Engineering* apply equally for the *master's programme Medical Engineering.*

Admission requirements
Consultation of the three universities of technology resulted in direct access to the programme with a Bachelor Biomedical Engineering of University of Twente or Life Science & Technology from the Delft University of Technology. Moreover, it was decided that several other Bachelor degrees allow access after a so-called deficiency programme has been completed of maximally 30 EC within one study year.

University of applied sciences (HBO) bachelor's degrees do not allow students to directly enter the programme. It is accessible, under certain conditions, for students with an HBO-bachelor's degree in Electrical Engineering, Physics, Chemistry, Mechanical Engineering, Biometry, and Higher Laboratory Education. Specialisation in (bio) medical engineering within these degrees is advantageous, but not required. After a successful personal intake consultation, the HBO bachelor has to enter a deficiency programme that has to be completed within one year; no extension of this period is allowed.

Most students entering the programme came from the bachelor's programme of the own department. Intake of foreign students is hampered by the requirement of Dutch fluency for patient contact in the clinic.

Over the last 6 years, a total of 45 students entered the pre-master programme. The success rate is only 33%. Six of the successful students entered the programme; the others went into the *master's programme Biomedical Engineering.*

The committee studied the admission requirements and believes they are clear for each group of enrolling students.

2.3 Quality and quantity of staff
On 1-1-2011, the department employed nine full professors (eight that are group leaders), seven associate professors, fourteen assistant professors and ten part-time professors. The

staff has an average time allocation of 40% for education, 40% for research and 20% for managerial tasks. At present, the programme reached a stable level of enrolled students of about 480. The result is a ratio of 1 fte permanent staff for about 15-20 students, or 1 fte education personnel for 27 students.

Every staff member must obtain the Basic Qualification Education ('Basis Kwalificatie Onderwijs', BKO). To this end, young staff members enter an education programme. The programme is completed with a report, which is assessed by the BKO committee. This marks also the start of the portfolio. Older staff members assemble their portfolios to be evaluated by the BKO committee, based on a national reference with quality norms established by VSNU (Association of collaborating Netherlands universities). Moreover, all staff members are evaluated by TU/e for their proficiency of English according to the Cambridge English Proficiency. Staff should minimally be at the C1 level. If the C1 level has not been achieved, the staff member must take a course to make up for the deficiency.

The PhD students are also involved with the supervision of the master students. Before they start, they must complete the TU/e special course Supervision of Master students.

Staff members are evaluated yearly. This is done at various levels: the group professor is responsible for the evaluation of his staff members. The evaluation reports are sent to the Dean who evaluates the reports together with the responsible group professor. Individual evaluation of full professors is done by the Dean. The performances of the professor groups are evaluated by the Dean (research and management) together with the Director of Education (education accomplishments of the group). In this setting, task agreements are made for the group for the upcoming period. An important aspect of the yearly assessment of all staff is the agreement on the (expected) progression of the individual career.

The committee studied the information provided on the teaching staff and discussed the quality and quantity of staff in the meetings. Students reported to the committee that it is quite easy to contact the staff. Appointments can easily be made and staff reacts adequate on questions of students. Other positive remarks from the students about the teaching staff are the open way they listen to criticism about the education and the proficiency of English. The committee concludes that the teaching staff is involved in actual innovative research and internationally well known. According to the committee, the staff background in biomedical engineering is very good. The staff is enthusiastic and supportive for the students.

2.4 Facilities

The university has various central facilities for educational purposes, chiefly consisting of lecture and instruction rooms (Auditorium) and library facilities. Examination rooms are also provided in the central facilities.

The department biomedical engineering shares with the department of Mechanical Engineering a building with a lecture hall, laboratories, etcetera. This lecture hall is mainly used for lectures of the first and second curriculum year, lectures by speakers from outside the university, and for official meetings, for example the presentation of certificates. Part of the staff of the department biomedical engineering and their laboratories are located in the buildings of Applied Physics and Chemical Engineering & Chemistry where they have office space and (share) research facilities (laboratories).

The education of the *master's programme Medical Engineering* mainly takes place in the Academic Hospital in Maastricht. Lectures (compulsory and elective) are given in Eindhoven and in

Maastricht. In Maastricht, lecture facilities are also available at the various participating clinical departments. Internships and graduation projects usually take place in the research and development groups of the Academic Hospital in Maastricht (or another hospital), sometimes in a basic research and development laboratory with clinical affiliation, or in a company. Each of these groups has the facility to accommodate the students for their experimental and theoretical work.

The committee thinks the facilities are adequate for realising the programme. The buildings are well equipped with state of the art facilities. The committee was led around the laboratories and was impressed by the diversity, quality and flexibility of the experimental setups with which bachelor and master students can have excellent hands-on experience.

Considerations

Bachelor's programme Biomedical Engineering
According to the committee, the content and structure of the bachelor's programme enables the admitted students to achieve the intended learning outcomes. The courses comprise basic knowledge in all fields related to biomedical engineering: mathematics, the sciences and life sciences. It is clear to the committee that the bachelor's programme makes a choice for and focuses on biomedical research. Research, as well as recent developments in the field, have a prominent place in the programme. However, the committee believes that some other disciplines are underexposed: design, entrepreneurship, business culture, risk assessment and regulatory affairs, social competences and reporting in writing need more attention.

The committee believes there is a nice mix of teaching forms available. The teaching-learning concept that structures the programme is in the view of the committee very good and supportive for the learning process of the students. The combination of courses and DCL provides students with the opportunity to learn in a varying environment with a good balance between theory, practical work and research. Within the programme, several essential skills are trained. However, the committee was missing a clear overview of the coherence and could not see how the skills build up within the programme.

The committee observed that the programme management is well aware that the student progress should be improved. In September 2012, the programme started implementing a new curriculum for the bachelor's programme, which is more tailored to the students. Amongst other expectations, it is believed this will improve student progress. The committee welcomes the idea of educating broad bachelor students, but advises the programme to maintain the focus on engineering, although in a biomedical setting.

The facilities are good and support the teaching-learning concept by enabling the students to work together on projects and assignments and to perform small scale research and design projects. The committee was impressed by the diversity, quality and flexibility of the experimental setups with which bachelor and master students can have excellent hands-on experience.

The teaching staff is involved in actual innovative research and internationally well known. The staff background in biomedical engineering is very good. The staff is enthusiastic and supportive for the students.

In the opinion of the committee, the *bachelor's programme Biomedical Engineering* is a challenging and interesting programme of high level, providing the students with a broad, but thorough education well preparing for a master's programme in biomedical engineering. Although there are some improvements possible, based upon the quality of the teaching forms, the facilities and the teaching staff, the committee concludes that the teaching-learning environment of the programme is good.

Master's programmes
The committee studied the curriculum of the master's programmes and concludes that the programmes offer students sufficient depth in the engineering field related to clinical practice. The programmes enable the students to develop their competences in medical engineering on an advanced level and prepare the students for continuing their studies in a PhD programme or to fulfil a position in the labour market for which an advanced scientific education in (bio)medical engineering is required. The master programmes are interesting and challenging, according to the committee. They provide a good balance between fundamental and applied science.

Students have the possibility to shape their master's programme according to their own individual wishes and interests. They select elective courses that suit their field of specialisation. To ensure a well-balanced programme with sufficient depth and diversity, the complete set has to be approved by the graduation professor: a full professor. The committee repeats that a large responsibility for the quality of the graduates remains with this graduation professor.

Students participate in research departments and are involved in innovative high level research projects. The committee is convinced that the students receive sufficient guidance and supervision during their internship and master thesis project.

With regard to the *master's programme Medical Engineering*, the committee advises to monitor closely the workload and study delay of students and remove schedule problems were possible.

Although there are some improvements possible for the master's programmes, based upon the quality of the teaching forms, the facilities and the teaching staff the committee concludes that the teaching learning-environment of the programmes is good.

Conclusion

Bachelor's programme Biomedical Engineering : the committee assesses Standard 2 as **good**.
Master's programme Biomedical Engineering: the committee assesses Standard 2 as **good**.
Master's programme Medical Engineering: the committee assesses Standard 2 as **good**.

Standard 3: Assessment and achieved learning outcomes

The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

Findings

For this standard, the assessment methods (3.1) and the achieved learning outcomes (3.2) of the *bachelor's programme Biomedical Engineering*, the *master's programme Biomedical Engineering* and the *master's programme Medical Engineering* are discussed.

3.1 Assessment methods

The assessment methods are described separately for the bachelor's programme and for both master's programmes.

3.1.1 Bachelor's programme Biomedical Engineering

Exams are taken at the end of each quarter. For the courses, the traditional written exam is widely used. In a growing number of courses, the use of a laptop with some specific software programme is necessary. Exams are taken in the final two weeks of a quarter.

The propaedeutic courses of the first quarter are also examined at midterm. Participation is not mandatory. The midterm exams help students to identify at an early stage their strengths and weaknesses. If a student passes this midterm exam, the final exam will only be about the remainder of the course. Always, the midterm exam can be repeated during the final exam. Grades obtained at midterm (or its resit) contribute 40% to the final grade. This relative weight was chosen so even students with a low score, could pass with a good score in the final exam. However, owing to its signalling function, the midterm exam loses its value after the quarter it was taken.

Exams are made and corrected by the team responsible for the course: the lecturer and the co-lecturer who assists with the Guided Self-study. Model solutions are available after the exam and students have the right to inspect their grading of the exam components and discuss the outcome within twenty working days after publication of the result. Each course has at least one re-sit in the same study year. Re-sits are at the end of the quarter following the course quarter.

For each DCL case, the case coordinator defines a number of specific educational goals. The case coordinator in combination with the group's tutor assesses to what extent the work of the group and the contribution of the individual student meet the specific objectives. Assessment of DCL has two components: a group component and an individual one. The case report of the group is graded by the Case Coordinator. The individual student assessment is done by the tutor in combination with peer review by the students. The tutor grades each student. Each student is graded by all fellow students of the group. All the grades, of the group, of the tutor and of the peer review, have to be a pass. Only then the final grade is determined.

The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. There is a variety of assessment forms and there is a good balance between individual assignments, group assignments and peer review.

The committee met with the Board of Examiners during the site visit and discussed the activities the Board carries out, in regard to the quality assurance of the exams. The committee concludes that the Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. The members of the Board of Examiners told the committee that they discussed at TU/e level how they should ensure the quality of the assessment. Regulations are set up at TU/e level. The Board of Examiners started implementing a more intensive quality control by following the average exam grades and pass percentages. When passing rates are too low or very high, the Board discusses the course with the teaching staff. The committee appreciates the fact that the Board of Examiners started out with activities in regard to the quality assurance of the exams, but thinks this needs more elaboration. According to the committee, the Board should not only focus on the end products like they do now, but monitor the whole quality process. The committee strongly recommends the Board to develop a specific plan on how to carry out the assurance of the assessment, in short term. The committee noticed that the Board of Examiners needs to treat many individual cases every month, partly because of the check on the individual programming of the master's programmes. Because of the busy agenda of the Board of Examiners, it might be useful to establish a new committee for carrying out the assurance of assessment, for instance an assessment committee ('toetscommissie').

3.1.2 Master's programme Biomedical Engineering and master's programme Medical Engineering

The elective courses are evaluated using written or oral exams or assignments. Grades are given by the responsible teacher. Grades of internships are given by the responsible staff member. In case of an externship, the presentation is given at both the receiving institute and the mentor's lab; the grade of the report of the foreign mentor is usually accepted by the graduation professor.

Students reported to the committee that they do receive some training and feedback on how to write reports, but that they do not learn exactly on what criteria they will be assessed. In addition, the committee noticed that there are no uniform prescriptions on how to write essays or reports. Research groups differ in the way they assess reports. According to the teaching staff, this is due to the different ways the different research groups are used to set up their reports. It is a broad department; reports of projects within Imaging and Modelling have other setups than reports of Molecular Bioengineering projects, for example. However, the committee strongly recommends to develop standards for assessing reports and other writings. The committee thinks it should be possible to make a standard for biomedical engineering.

The committee examined the learning assessment procedure and looked into a selection of assessments. The committee concludes that assessments are adequately related to the programme. However, especially for the internships and externships, the transparency of the assessment can be improved, ensuring that all students are objectively assessed according to the same criteria. The committee strongly recommends to develop assessment criteria and assessment forms for internships and externships.

The comments of the committee on the activities of the Board of Examiners, reported in the section on the bachelor's programme, apply equally for the master's programmes.

3.2 Achieved learning outcomes

The achieved learning outcomes are described separately for the bachelor's programme and for both master's programmes.

3.2.1 Bachelor's programme Biomedical Engineering

In the academic year 2009-2010 the programme introduced the major (or final) project of 12 EC, where students apply the acquired knowledge and skills in an integrated way. The graduation project is concluded with a thesis and an oral presentation.

The committee assessed fifteen recent bachelor theses and established that all theses met the requirements for graduation. On average, the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses are short (fifteen to twenty pages), but the depth of the theses is quite good, according to the committee. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. However, the committee was surprised to see that the chosen form of the theses can differ significantly. For example, one thesis was written as a literature review and a research proposal. The committee feels that a more standard guideline for writing a bachelor theses is needed.

The bachelor's programme and the master's programmes use (almost) the same assessment form (in Dutch, named 'Beoordelingsformulier afstudeerproject' or 'Beoordelingsformulier major project') for assessing bachelor and master assignments. Seven aspects of assessments are distinguished: independent work ('zelfstandigheid'), analytical ability ('analyserend vermogen'), creativity/inventiveness ('creativiteit/inventiviteit'), practical/experimental skills ('praktische/experimentele vaardigheden'), written reporting ('schriftelijke rapportage'), presentation ('afstudeervoordracht') and oral defence ('mondelinge verdediging'). It is not clear how the grades on the different aspects come together in the final grade and the grades are not explained on the assessment form. The committee recommends to develop an extended form for each of the three programmes, in which the intended learning outcomes of the programmes are reflected. On the forms, every member of the assessment committee should be able to make his or her remarks independently. In addition, it needs to be made clear how the comments on every aspect of the assessment come together in the final grade. Furthermore, a clear description of the meaning of the several grades, connected to the aspects of the assessment of the bachelor assignment, needs to be developed. A systematic use of a scoring chart and the use of own grading descriptions is needed. The committee recommends to make sure this document is known by the students and staff, and to keep this as a record.

3.2.2 Master's programme Biomedical Engineering

The *master's programme Biomedical Engineering* is concluded with a graduation project executed in the lab of the graduation professor, or any lab of the graduation professor's choice. During the graduation project the student usually works on part of a project of a PhD-student. According to the self-evaluation report, the graduation project is an extensive assignment with a high degree of independence as a member of a (multidisciplinary) research team. It may be focused on conducting research or carrying out a design assignment. Indeed, researching and developing form the basis of biomedical engineering. The specialisation assignment usually consists of a contribution to the current research programme within the Department of Biomedical Engineering. During the final project the student is part of a

group of experienced researchers and PhD students. The graduation project is concluded with a thesis and an oral presentation. The content of the Master's thesis usually forms part of the thesis of the PhD student with whom the graduate student interacted. Other graduating students usually continue this work.

The final products of the graduation project are a written report and a presentation. The Master's thesis is initially judged by the responsible professor and his co-workers. If the thesis is considered to be of appropriate quality, the thesis is submitted to a thesis committee, consisting of the responsible full professor, the associate (assistant) professor who mentored the student on a daily base, and at least two other members, one of them being from another professor group. Subsequently the public Master's seminar is given in attendance of the thesis committee. This is followed by a private interrogation (about one hour) of the candidate by the thesis committee. Acknowledging that a graduation professor is an expert in the field, implicates that he is in principle responsible for the level of the grades. The presence of a colleague from another division provides the necessary general BME view.

The committee assessed fifteen recent master theses of the *master's programme Biomedical Engineering* and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. Several thesis are graded higher by the committee than by the programme.

The comments of the committee on the need of a more extended assessment form, reported in the section on the bachelor's programme, apply equally for the *master's programme Biomedical Engineering.*

3.2.3 Master's programme Medical Engineering

The *master's programme Medical Engineering* is not aiming at a professional education, but at (clinical) research and development. The graduation project should focus on a specific well-defined (clinical) research idea. The resulting Master's thesis should ideally be at the level of a publishable paper in an international journal. Besides, the work should also be presented and defended in a seminar.

The graduation project is executed in the clinic or in clinical evaluation sections of a company. The graduation project can be done at the various clinical departments of the Academic Hospital in Maastricht or another affiliated hospital, and in due time in university research and development labs and companies related to this clinical field via the part-time professors, provided a good scientific infrastructure is available and continuity of collaboration is guaranteed. The presence of PhD students is considered to be beneficial because their presence ensures the right academic environment. Supervision is with a biomedical engineering professor and with a clinical professor, the 'graduation duo'; direct interaction is often with PhD students.

It is essential that the graduation project is performed in a clinical setting. It should be based on a problem definition of the environment of an Medical Doctor, clinical physicist/chemist and it should aim at diagnosis and/or treatment of patients. This clinician is directly involved in the project and is member of the graduation committee. The student has regular personal contact with the clinician to acquire good insight in the problem. Participation in the research in the clinic is an essential part of the graduation. This warrants that a graduate has acquired clinical experience and knows what it means to work in a hospital.

The final products of the graduation project are a written report and a presentation. The thesis is initially judged by the responsible medical engineering professor and his co-workers. If the thesis is considered to be of appropriate quality, the thesis is submitted to a thesis committee, consisting of the responsible full professor, the associate (assistant) professor who mentored the student on a daily basis, and at least two other members, one of them being a clinician. Subsequently the public Master's seminar is given in attendance of the thesis committee. This is followed by a private interrogation (about one hour) of the candidate by the thesis committee. Acknowledging that a graduation professor is an expert in the field, implicates that he is in principle responsible for the level of the grades. The presence of a colleague from another division provides the necessary general biomedical engineering view.

The committee assessed fifteen recent master theses of the *master's programme Medical Engineering* and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. Several theses are graded higher by the committee than by the programme.

The comments of the committee on the need of an assessment form, reported in the section on the bachelor's programme, apply equally for the *master's programme Medical Engineering.* The committee studied theses of both master's programmes and established that the theses of both master's programmes do not differ much in nature. The theses of the *master's programme Medical Engineering* should be more embedded in clinical practice, but the committee didn't see that reflected in the theses. When making more specific assessment forms for the different programmes, the committee advises the *master's programme Medical Engineering* to make the differences between the two graduation projects more reflected in the assessment criteria. In addition, this needs to be reflected in the templates on how to perform the graduation project and on how to write the thesis.

Considerations

The committee has established that both the bachelor's and the master's programmes have adequate assessment systems and assessment procedures. The assessment procedures are sufficiently implemented in the programme.

The Board of Examiners performs most of its legal tasks, but does not yet pro-actively control the quality of the exams, the assessment procedures and graduation theses. The committee strongly recommends the Board to develop in short time a specific plan on how to carry out the assurance of the assessment.

The committee assessed fifteen recent bachelor theses, fifteen master theses of the *master's programme Biomedical engineering* and fifteen master theses of the *master's programme Medical engineering,* and established that all theses met the requirements for graduation. On average the theses are of sufficient quality. The committee has not seen theses that were on the whole unsatisfactory. The theses illustrate that the students have achieved the intended learning outcomes as formulated by the programme. Several theses of the master's programmes are graded higher by the committee than by the programme.

In the past years a common assessment form is used for the final assessment of bachelor and master students. The committee recommends to differentiate between bachelor and master level and to develop an assessment form specifically for each programme. Furthermore the committee strongly recommends that these assessments forms are filled in by all supervisors in a uniform way. It needs to be clear how the comments on every aspect of the assessment come together in a final grade. In addition, a more systematic use of a scoring chart and the use of own grading descriptions is needed. The committee recommends to make sure this document is known by the students and staff, and to keep this as a record. Finally, the committee recommends to develop an assessment form on which every member of the assessment committee can make his or her remarks independently.

The committee established that the theses of both master's programmes do not differ much in nature. The theses of the *master's programme Medical Engineering* should be more embedded in clinical practice, but the committee didn't see that reflected in the theses. The committee advises the *master's programme Medical Engineering* to make the differences between the two graduation projects more reflected in the assessment criteria. In addition, this needs to be reflected in the templates on how to perform the graduation project and on how to write the thesis.

Conclusion

Bachelor's programme Biomedical Engineering : the committee assesses Standard 3 as **satisfactory**.
Master's programme Biomedical Engineering: the committee assesses Standard 3 as **satisfactory**.
Master's programme Medical Engineering: the committee assesses Standard 3 as **satisfactory**.

General conclusion

The committee concludes that the bachelor's programme Biomedical Engineering, het master's programme Biomedical Engineering and the master's programme Medical Engineering meet the requirements for accreditation.

Conclusion
The committee assesses the *bachelor's programme Biomedical Engineering* as **satisfactory**.
The committee assesses the *master's programme Biomedical Engineering* as **satisfactory**.
The committee assesses the *master's programme Medical Engineering* as **satisfactory**.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Prof. Dr. ir. J. (Jos) Vander Sloten obtained his PhD in Applied Sciences with Greatest Honours in 1990 at the KU Leuven. Since 1999 he is Full Professor at the Division of Biomechanics and Engineering Design of the KU Leuven. From 2006 until 2012 he was Programme director of the Master of Science programme in Biomedical Engineering at the same university. Since 2000, Professor Vander Sloten is chair of the CRITTO (Commissie Ruimtelijk Inzicht, Technisch Tekenen en Ontwerpen, Technologisch Instituut, Koninklijke Vlaamse Ingenieursvereniging). He is also a member of the Boards of Custom 8 N.V. (a KU Leuven spin-off company) and Materialise N.V., and is a member of various scientific advisory boards and editorial boards of scientific journals.

Dr. J. (Jan) Struijk obtained his PhD at the Biomedical Engineering Division of the University of Twente in 1992. His thesis was called *Immediate Effects of Spinal Cord Stimulation.* He was Visiting Professor in 1988, at Case Western Reserve University, Cleveland (USA). He was Associate Professor at the Department of Medical Informatics and Image Analysis at Aalborg University (Denmark). Subsequently, he was Director of Studies, Medicine and Technology, Head of Center for Sensory-Motor Interaction/Motor Control and Neurorehabilitation Technology, and since 2009 Associate Professor at the Medical Informatics Group, all of the Department of Health Science and Technology. He also was Chairman and member of several PhD evaluation committees.

Prof. Dr. ir. J.A.E. (Jos) Spaan is Emeritus Professor in Medical Physics at the Academic Medical Centre of the University of Amsterdam since February 2010. In 1970 he got a degree in Engineering, Physics at TU Eindhoven. In 1976 he obtained his PhD at the same university. His thesis was entitled *Oxygen transfer in layers of hemoglobin solutions.* He had appointments at various universities in the Netherlands: TU Delft, University of Leiden and University of Amsterdam. Professor Spaan also was Secretary General of the International Federation of BioMedical Engineering (1992-1998), Chairman of the Cardiovascular Research Institute Amsterdam (2003-2005) and the first elected president of the European Alliance of Medical and Biological Engineering and Sciences (2005).

Prof. dr. R. (Richard) Reilly got a degree in Biomedical Engineering (1989) and obtained his PhD in Biomedical Signal Processing (1992) at University College Dublin. He is and was researcher and biomedical engineer in various hospitals and institutes. He is currently Full Professor of Neural Engineering at the School of Medicine and School of Engineering of Trinity College Dublin and director of the Trinity Centre for Bioengineering. Professor Reilly also is President of the European Society of Engineering and Medicine (2011-2015).

J.Y. (Jan-Yme) de Boer is bachelor student Biomedical Engineering at the University of Twente. He is as board member of the Twente study association Paradoks and responsible for educational affairs. He is furthermore advisor to the Education Committee Biomedical Engineering at the University Twente and involved in the national meetings of Biomedical Study Associations.

Appendix 2: Domain-specific framework of reference

Mission statement Bachelor Biomedical Engineering

Biomedical Engineering is an interdisciplinary field, combining engineering disciplines and natural and life sciences. Integrating scientific and engineering concepts and methodology the Biomedical Engineer works to increase scientific knowledge and solve health care problems, by:

1) acquiring new knowledge of living systems through continuous innovation and substantive application of experimental, analytical, and design techniques.
2) design and development of new devices, algorithms, processes and systems to advance Medical Technology in health care.
3) solving health care problems through purposeful context-driven problem solving;
4) implementing solutions using excellent cross-disciplinary communication and cooperation.

Domain-specific reference framework and final qualifications

A. Domain specific requirements for level and orientation of graduates

Biomedical Engineering (biomedical engineering) is an engineering discipline focused at the interface of engineering and life sciences. biomedical engineering education should include basic general engineering requirements (as for example indicated by ABET) and a thorough understanding of life sciences. biomedical engineering programs must demonstrate that their students attain, according to the shared Dublin descriptors:

Knowledge and understanding:

a. Knowledge of the basic disciplines mathematics, sciences, and engineering (mechanical, electrical, and chemical engineering and applied physics) to be applied in the field of Biomedical Engineering in a broader sense; i.e. including directly adjacent fields.
b. Knowledge and understanding of concepts of physiology, (cell-) biology, anatomy, biochemistry, pharmacology and pathology as applicable in the field of Biomedical Engineering.

Applying knowledge and understanding:

c. The capability to apply and integrate advanced mathematics, sciences, and engineering to model and solve complex biomedical problems (see also d).

Making judgments:

d. An ability to conduct scientific research in areas of biomedical engineering and technology that are relevant to the advancement of knowledge and insight into fundamental and applied aspects of health and disease.
    - An ability to make measurements on and interpret data from living systems, addressing problems associated with the interaction between living and non-living materials and systems.
    - An ability to translate a clinical or health-relevant problem or question into an experiment, system, component, or process (design) to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.

Communication:

e. A capability to bridge the gap between fundamental and applied research in biomedical engineering and medical (life) sciences by:
   - Demonstrating an ability to communicate effectively in written and verbal form, and
   - Collaboration in a multidisciplinary setting, which may include clinicians, other healthcare workers and industrialists alike.

f. An awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of his research.

Learning skills:

g. An ability to develop new concepts within the field of biomedical engineering.
h. An ability to study international scientific research.
i. Recognition of the need for, and an ability to engage in life-long learning.

B. Domain specific requirements of the BSc (Cycle 1) and MSc (Cycle 2) programs

The Bachelor's program focuses on general knowledge, based on advanced textbooks and including some aspects informed by knowledge of the forefront of their biomedical engineering specialization, basic skills and solving recognizable problems.

The Master's program focuses on deepening theoretical knowledge in one or more specific parts of Biomedical Engineering and provides ample experience in setting up, executing and reporting research and design. It leads to an attitude of scientific involvement.

BSc students acquire knowledge and understanding in:

a. Basic beta disciplines: mathematics, sciences, and engineering (mechanical, electrical, and chemical engineering and applied physics) to be applied in the field of Biomedical Engineering in a broader sense; i.e. including directly adjacent fields.
b. Life sciences: physiology, (cell-) biology, anatomy, biochemistry, pharmacology and pathology as applicable in the field of Biomedical Engineering.

BSc students learn to apply knowledge and understanding:

a. Of mathematics, sciences and engineering to model and solve simple biomedical problems.

BSc students learn to make judgments:

b. Involving the making of measurements on and the interpretation of simple data from living systems, addressing the problems associated with the interaction between living and non-living materials and systems at a basic level.
c. Involving the ability to translate simple clinical or health-relevant problems or questions into an experiment, system, component, or process to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.
d. By demonstrating an awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of his research.

BSc students learn to communicate:

e. By bridging the gap between fundamental and applied research in biomedical engineering and medical (life) sciences by:

- Demonstrating an ability to communicate effectively in Dutch in written and verbal form, and
- Collaboration in a multidisciplinary setting.

BSc students acquire learning skills:

f. As demonstrated in their recognition of the need for, and an ability to engage in lifelong learning at the BSc+ level with a high level of autonomy.

MSc students acquire knowledge and understanding:

a. Of in depth biomedical engineering, in a coherent set of specialties, that builds on the basic knowledge acquired in the Bachelor's phase, and that provides a basis or opportunity for originality in developing or applying ideas in this specialization.

MSc students learn to apply knowledge and understanding:

a. In order to apply and integrate advanced mathematics, sciences and engineering knowledge as well as specialized knowledge to model and solve complex biomedical problems in new and unfamiliar environments.

MSc students learn to make judgments:

b. In an ability to conduct scientific research in areas of biomedical engineering and technology that are relevant to the advancement of knowledge and insight into fundamental and applied aspects of health and disease.
- An ability to make measurements on and interpret complex data from living systems, addressing the complex problems associated with the interaction between living and non-living materials and systems, and the ability to successfully recognize and address new problems in this field.
- An ability to translate a complex, not well-defined, clinical or health-relevant problem or question into an experiment, system, component, or process to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.

MSc students learn to communicate:

c. With a capability to bridge the gap between complex fundamental and applied research in biomedical engineering and medical (life) sciences by
- Demonstrating the ability to communicate effectively in written and verbal form in Dutch and English, by underpinning knowledge and rationale (restricted scope) to specialist and non-specialist audiences alike, and
- Collaboration in a multidisciplinary setting, which may include clinicians, other healthcare workers and industrialists alike.

d. An awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of the research carried out under his responsibility.

BSc students acquire learning skills

e. An ability to study international scientific research.

f. Recognition of the need for, and an ability to engage in life-long learning at MSc+ level in a manner that may be largely self-directed or autonomous.

Appendix 3: Intended learning outcomes

Bachelor's programme Biomedical Engineering

When graduating with an academic Bachelor in Biomedical Engineering, the students:

A. Have a broad technological-scientific basic knowledge and understanding in the field of Biomedical engineering:

- The BMT Bachelor has acquired such a base of academic knowledge in the field of Biomedical Engineering, that he is capable of interpreting Biomedical Engineering problems in the right manner.
- He understands the structure of Biomedical Engineering and the relationship between branches.
- He knows physical, chemical, mathematical, and engineering principles for the purpose of analysis and design at the interface of engineering and biology
- He has a solid understanding of (model-based) concepts from physiology, (cell) biology, anatomy, biochemistry, pharmacology and pathology.
- He understands the interplay between the various disciplines.
- He is capable of understanding and analysing complex processes and systems.
- He possesses skills of using advanced physical, chemical, mathematical and informatics methods and equipment.
- He is able to design and conduct experiments, including experiments on living systems.
- He possesses an interdisciplinary attitude.

B. Can apply his knowledge and understanding. He possesses general skills, required to carry out research and its applications and to pass on knowledge.

- The BMT Bachelor is capable of analysing problems in the field of Biomedical Engineering and of structuring and redefining poorly structured problems and can ask adequate questions in doing so.
- He is capable of acquiring and applying knowledge of disciplines required to solve Biomedical Engineering problems and, in the course of that process, to integrate knowledge from various disciplines.
- He has the skill of modelling, simulating, and experimenting and is capable of utilising state-of-the-art research facilities.
- He is capable of analysing and interpreting data, including data from measurements on living systems.
- He can reason logically within and outside the field of study, both 'why' and 'what-if' reasoning.

C. Can communicate and function in a team

- He is capable of participating in or directing scientific deliberations and of presenting oral or written reports of scientific knowledge and project results.
- He has the ability to communicate to both specialist and non-specialist audiences.
- The BMT Bachelor is capable of working in a multidisciplinary team, while using a project team approach.
- His contributions to the group process are constructive by taking and formulating personal stand points, by assuming responsibility for group assignments and keeping appointments.

D. Have the capability to reflect on relevant social, academic or ethical issues of Biomedical Engineering.

- The BMT Bachelor is capable of anticipating and analysing the consequences of his own decisions.
- He is capable of recognising ethical aspects of developments within his own discipline.

E. Have developed learning skills necessary for continued academic (self) education.

- He is capable, where necessary (and with support), of reviewing and expanding his own knowledge.

F. Have developed design skills.

- He is able to reformulate ill-structured design problems while taking into account system boundaries.
- He has creativity and synthetic skills with respect to design problems.
- He is aware of changeability of the design process through external circumstances or advancing insight.
- He is able to integrate existing knowledge in a design.
- He has the skill to take design decisions, and to justify and evaluate these in a systematic manner.

Master's programme Biomedical Engineering

-

Master's programme Medical Engineering

Intended learning outcomes with an asterisk * are added to the domain specific requirements.

M.Sc. students acquire

Knowledge and understanding:

a. Of in depth biomedical engineering, in a coherent set of specialties, that builds on the basic knowledge acquired in the Bachelor's phase, and that provides a basis or opportunity for originality in developing or applying ideas in this specialisation.

M.Sc. students learn to

Apply knowledge and understanding:

b. In order to apply and integrate advanced mathematics, sciences and engineering knowledge as well as specialized knowledge to model and solve complex biomedical problems in new and unfamiliar environments.

Making judgements:

c. In an ability to conduct scientific research in areas of biomedical engineering and technology that are relevant to the advancement of knowledge and insight into fundamental and applied aspects of health and disease.

- An ability to make measurements on and interpret and quantify complex data from living systems, addressing the complex problems associated with the interaction between living and non-living materials and systems, and the ability to successfully recognize and address new problems in this field.
- An ability to translate a complex, not well-defined, clinical or health-relevant problem or question into an experiment, system, component, or process to meet desired needs and, governed by scientific research or modelling, to advise in issues like clinical research in biomedical engineering, diagnosis and therapy.

** Develop well defined, efficient, effective, and patient-friendly protocols for diagnosis, decision making, and treatment.*

** Know how to (statistically) deal with inter- and intra- patient and observer variability, measurement errors and inaccuracies, incompleteness or absence of data.*

** Bring solutions back to treatment of patients.*

Communicate:

d. With a capability to bridge the gap between complex fundamental and applied research in biomedical engineering and medical (life) sciences by

• Demonstrating the ability to communicate effectively in written and verbal form in Dutch and English, by underpinning knowledge and rationale (restricted scope) to specialist and non-specialist audiences alike.

• Collaboration in a multidisciplinary setting, which may include clinicians, other healthcare workers and industrialists alike.

* *Including diagnosis and treatment of individual patients.*

e. An awareness of potential societal and ethical implications of scientific research in Biomedical Engineering and, in this context, an ability to critically evaluate the effects of the research carried out under his/her responsibility.

Learning skills:

f. An ability to study international scientific research.

g. Recognition of the need for, and an ability to engage in life-long learning at MSc+ level in a manner that may be largely self-directed or autonomous.

Appendix 4: Overview of the curricula

Bachelor's curriculum of the academic year 2011-2012 (old curriculum)

Courses are 3 EC each. Cases are 6 EC each, except for the cases of the first quartile ('The human combustion engine' and 'Drugs: 1+1≠2')

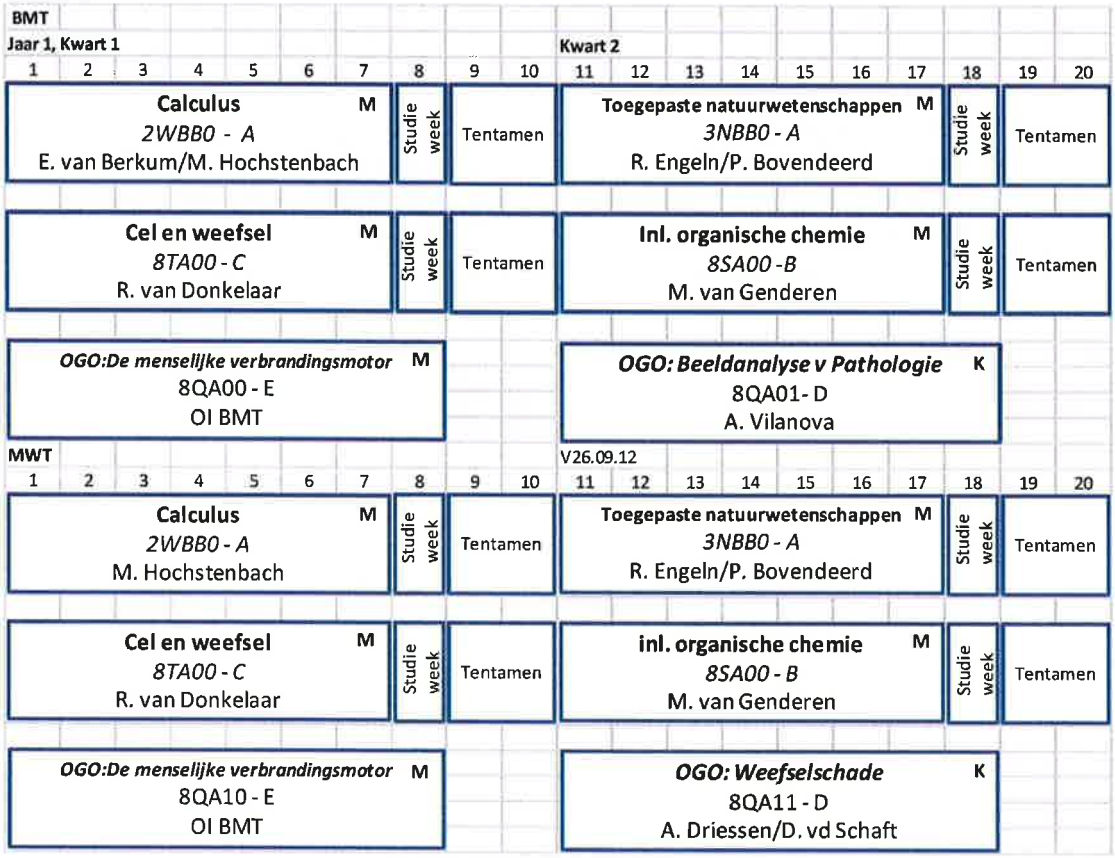
	Semester 1.A	**Semester 1.B**
Courses	Basic mathematics Physics in physiology Molecule and matter Calculus Bio-informatics Structure and function of cells and tissues	Organic chemistry A Linear algebra Introduction to measuring and modelling Vector calculus Organic chemistry B Biomechanics
Cases	The human combustion engine Drugs: 1+1≠2 Mechanics of a blood vessel	Molecular spies exposed with MRI Pathology and image analysis

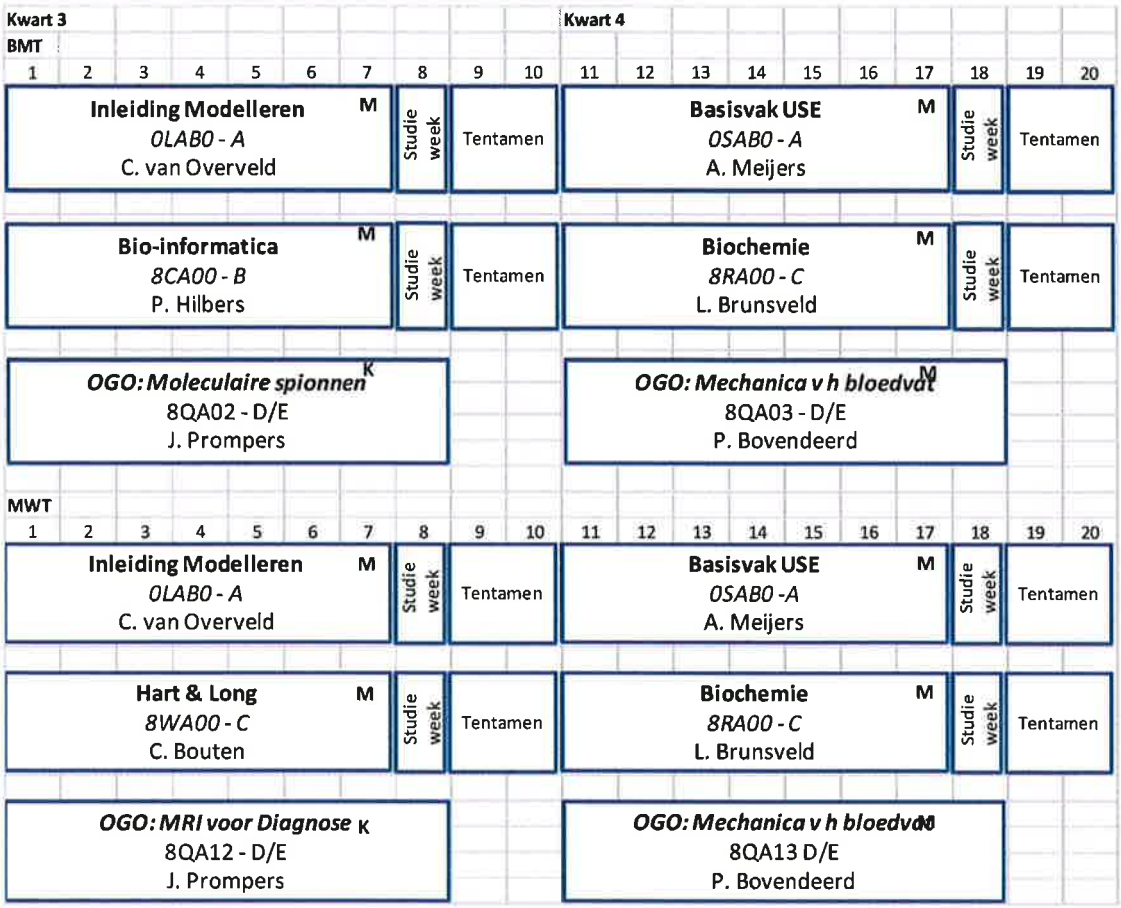
	Semester 2.A	**Semester 2.B**
Courses	Biochemistry Biostatistics 1 Signals and system analysis Molecular cell biology Materials science Continuum analysis	Algorithms for BIOMIM Electromagnetism Thermodynamics Flow and diffusion Basic image processing Energy balance
Cases	Metabolic networks in action Heart and body	'Entering the lab' Pericardial patches

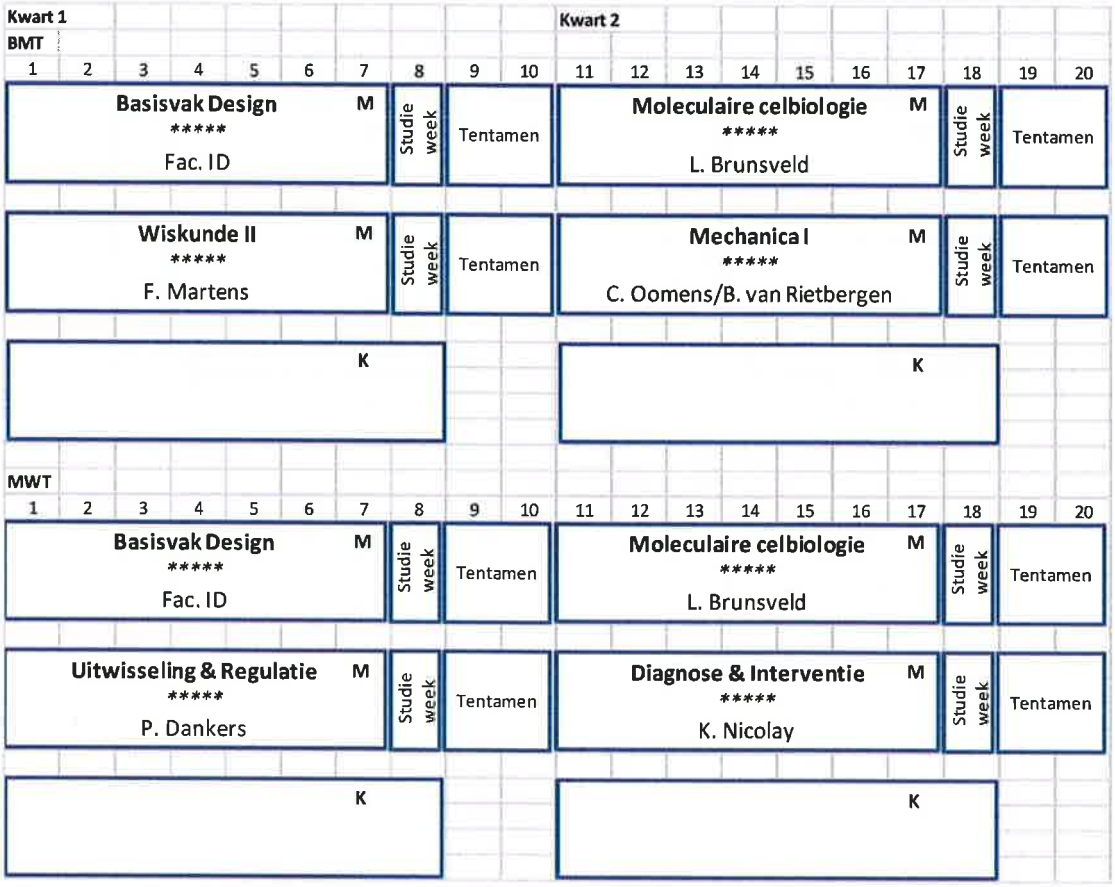
	Semester 3.A	**Semester 3.B**
Courses	(Minor)	Biostatistics 2 Simulations of biochemical systems Numerical analysis of continua I Structure and adaptation of cell and tissue Medical imaging 1 Optics
Cases	(Minor)	Major project

Bachelor's first year curriculum of the academic year 2012-2013 (new curriculum)

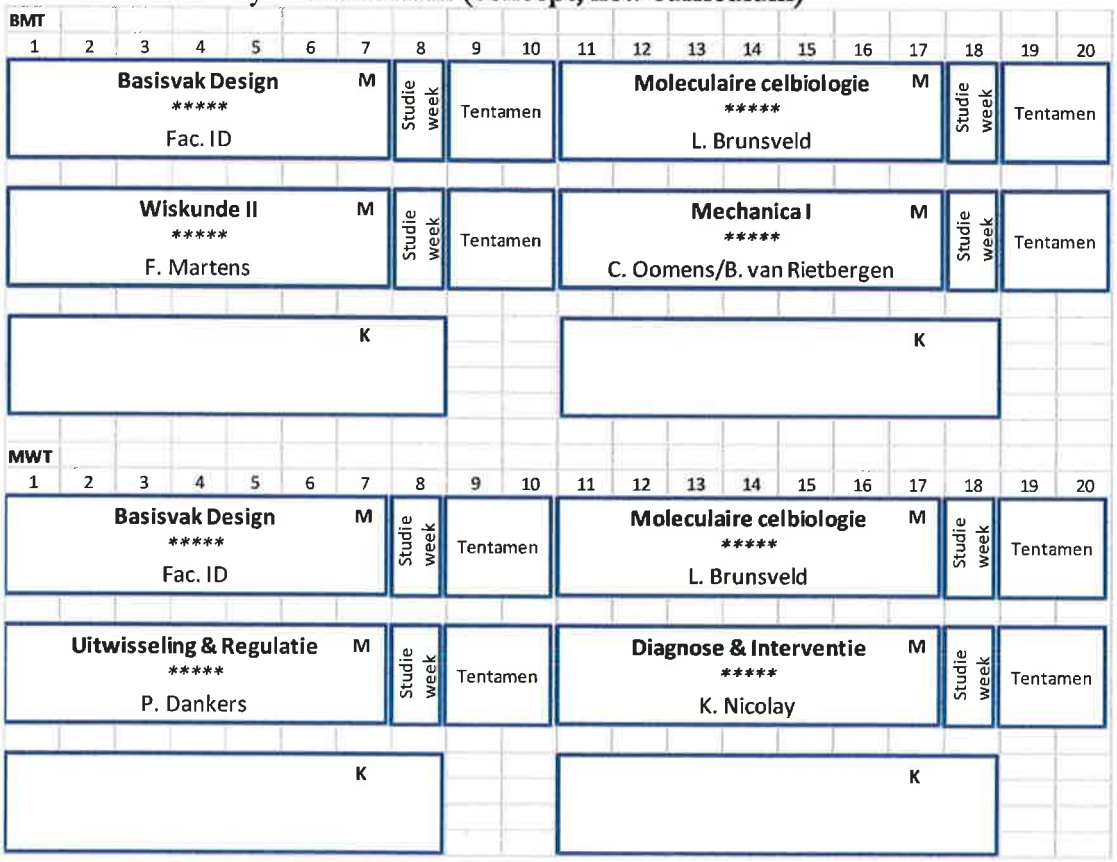
BMT: major Biomedische Technologie
MWT: major Medische Wetenschappen en Technologie

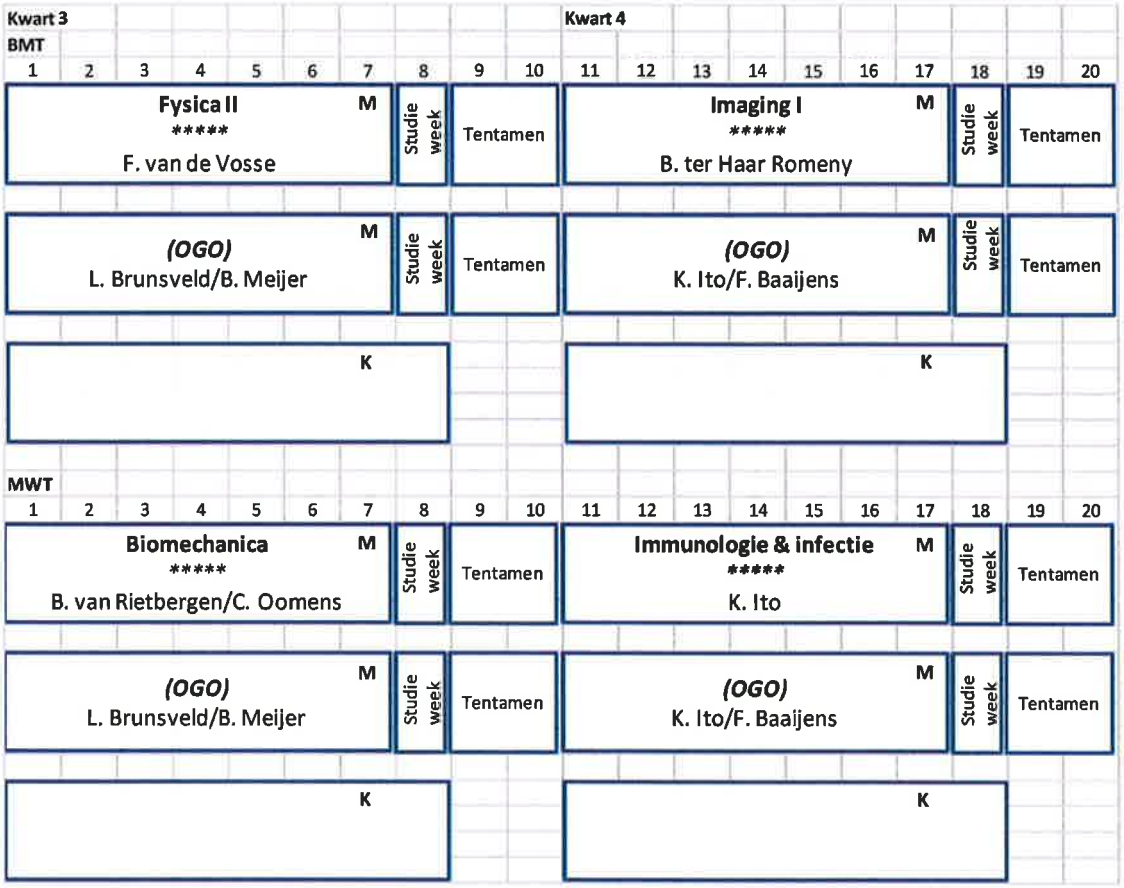



Kwart 3
Kwart 4
BMT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Inleiding Modelleren M
0LAB0 - A
C. van Overveld
Studie week
Tentamen
Basisvak USE M
0SAB0 - A
A. Meijers
Studie week
Tentamen
Bio-informatica M
8CA00 - B
P. Hilbers
Studie week
Tentamen
Biochemie M
8RA00 - C
L. Brunsveld
Studie week
Tentamen
OGO: Moleculaire spionnen K
8QA02 - D/E
J. Prompers
OGO: Mechanica v h bloedvat M
8QA03 - D/E
P. Bovendeerd
MWT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Inleiding Modelleren M
0LAB0 - A
C. van Overveld
Studie week
Tentamen
Basisvak USE M
0SAB0 -A
A. Meijers
Studie week
Tentamen
Hart & Long M
8WA00 - C
C. Bouten
Studie week
Tentamen
Biochemie M
8RA00 - C
L. Brunsveld
Studie week
Tentamen
OGO: MRI voor Diagnose K
8QA12 - D/E
J. Prompers
OGO: Mechanica v h bloedvat M
8QA13 D/E
P. Bovendeerd

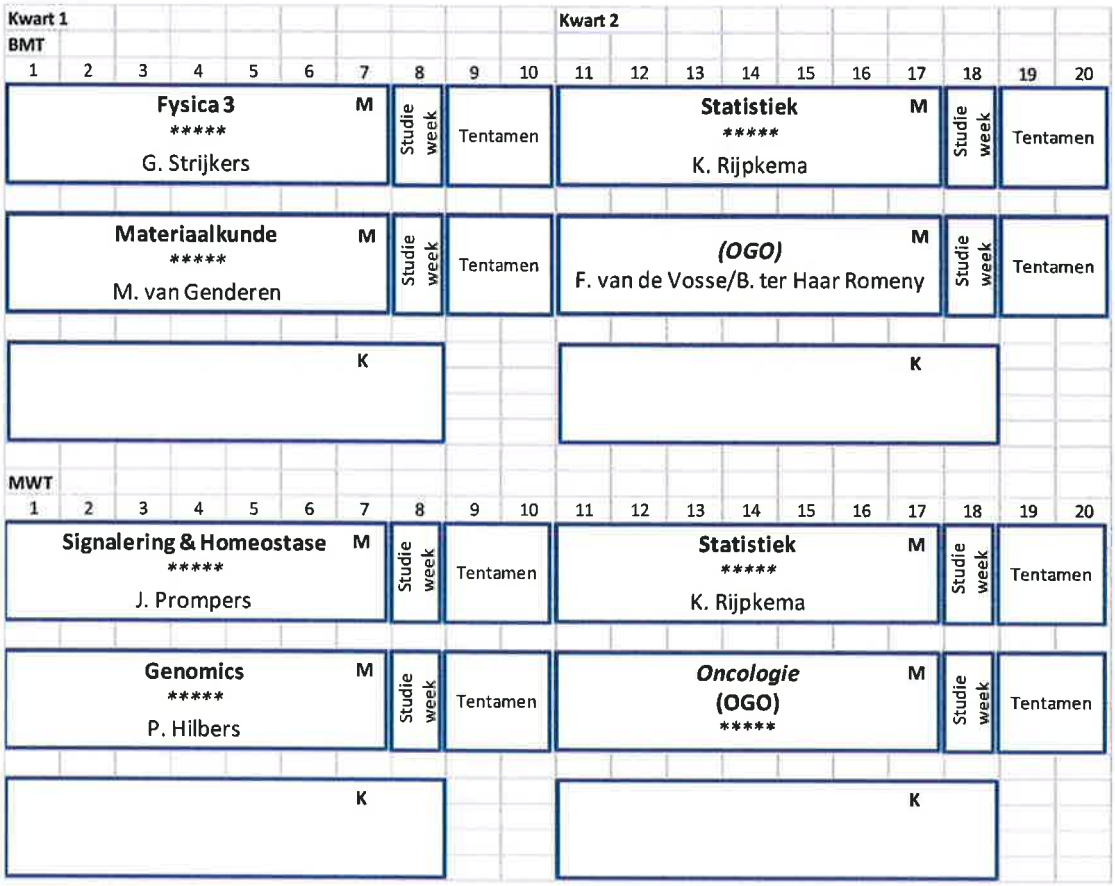


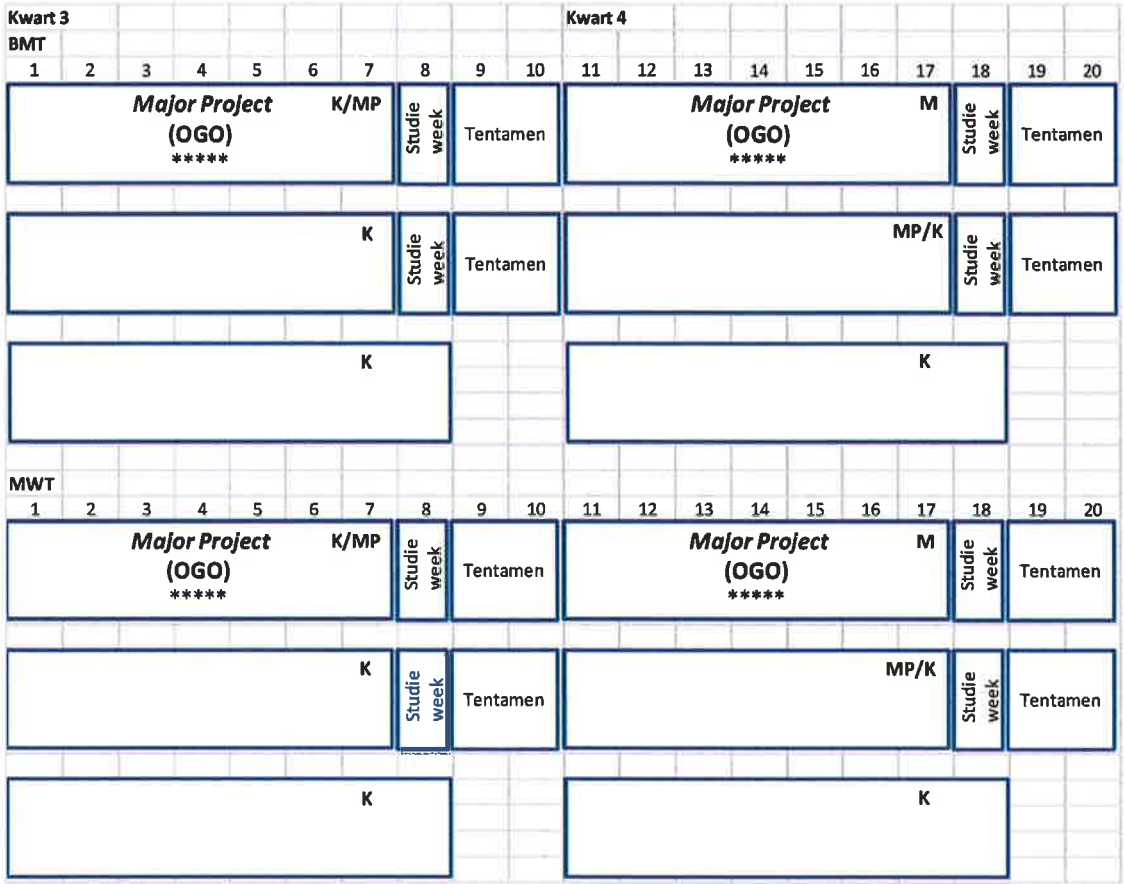
Bachelor's second year curriculum (concept, new curriculum)




Kwart 3
Kwart 4
BMT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Fysica II
*****
F. van de Vosse
M
Studie week
Tentamen
Imaging I
*****
B. ter Haar Romeny
M
Studie week
Tentamen
(OGO)
L. Brunsveld/B. Meijer
M
Studie week
Tentamen
(OGO)
K. Ito/F. Baaijens
M
Studie week
Tentamen
K
K
MWT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Biomechanica
*****
B. van Rietbergen/C. Oomens
M
Studie week
Tentamen
Immunologie & infectie
*****
K. Ito
M
Studie week
Tentamen
(OGO)
L. Brunsveld/B. Meijer
M
Studie week
Tentamen
(OGO)
K. Ito/F. Baaijens
M
Studie week
Tentamen
K
K

Bachelor's third year curriculum (concept, new curriculum)




Kwart 3
Kwart 4
BMT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Major Project (OGO) *****
K/MP
Studie week
Tentamen
Major Project (OGO) *****
M
Studie week
Tentamen
K
Studie week
Tentamen
MP/K
Studie week
Tentamen
K
K
MWT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Major Project (OGO) *****
K/MP
Studie week
Tentamen
Major Project (OGO) *****
M
Studie week
Tentamen
K
Studie week
Tentamen
MP/K
Studie week
Tentamen
K
K

Curriculum master's programme Biomedical Engineering

First year from cohort 2011

Course	EC
Electives	30
Free choice	9
Externship	21
Total	60

Course	EC
Graduation project	60
Total	60

Curriculum master's programme Medical Engineering

First year from cohort 2005

Code	Course	EC
	Electives	24
8F100	Clinical module: Oncologie [1)]	8
8F110	Clinical module: Hart- & vaatziekten [1)]	8
8F120	Clinical module: Neurologie [1)]	8
8F170	Clinical module: Orthopedie [1)]	8
8Z3xx [2, 3)]	Internship	20
	Total	60

Second year (M)

Code	Course	EC
8Z2xx [4)]	Graduation project	60
	Total	60

1) = Er moeten minimaal 2 klinische blokken worden gedaan.

Electives master track Imaging and Modeling (BIOMIM) (2012-2013)

Semester A

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
2DX00	Mathematical models in physiology	Duits	1	3
5LL80	Biomedical sensing technolgy	Mischi	1	3
5ME10	Statistical Signal processing	Amft	1	3
8B030	Physics of the senses [1)]	Kingma	1	3
8C050	Neural networks types and data analysis [2)]	Ten Eikelder	1	3
8D010	Front-end vision and multiscale image analysis	Ter Haar Romeny	1	3
8E070	Digital signal processing	Tjalkens	1	3
8J010	Energy-homeostasis [1)]	Plasqui	1	3
5MY00	Adaptive array signal processing	Sommen	2	3
5P500	Measurements on respiration and circulation	Worlee/Blom	2	3
5SC20	State space control	Ozkan	2	3
8C040	Molecular modelling	Markvoort	2	3
8D020	Mathematical techniques for image analysis	Florack	2	3
8E060	Neuromonitoring	Cluitmans	2	3
8E090	System analysis and parameter estimation	Van Riel	2	3

Semester B

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
5MB10	Model reduction	Weiland	3	3
5P060	Non-linear systems/Neural networks	Hegt	3	4
8C060	System biology	Van Riel	3	3
8D030	Techniques for computer aided diagnosis	Vilanova Bartroli	3	3

Electives master track BioMechanics and Tissue Engineering (BMTE) (2012-2013)

Semester A

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
4K400	Rheology	Peters	1	3
8W060	Biological mixtures	Huyghe	1	3
8W090	Cardiovascular fluid mechanics	Van de Vosse	1	3
8W080	Bone mechanics	Rietbergen	2	3
8W110	Pathophysiology of the cardiovascular system	Pijls	2	3
8W130	Tissue engineering	Bader	2	3
8W150	Multi-fluid mechanics	Anderson	2	3
8W160	Cardiac modeling	Bovendeerd	2	3
8W270	Fluid biomechanics	Van de Vosse	2	3
8W280	Tissue mechanics	Ito	2	3
8W330	Immunologie en infectie	Ito	2	3
8W340	Hart en long physiologie	Bouten	2	3

Semester B

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
3T111	Advanced fluid dynamics	Van Heijst	3	3
4K430	Computational rheology	Hulsen	3	3
4K720	Experimental methods in soft matter science	Wyss	3	3
4T300	Microscopic measurement methods	Hoefnagels	3	3
8W010	Cartilage mechanics	Van Donkelaar	3	3
8W300	Stem cells [1)]	Van der Schaft	3	3
8W310	Cardiovascular fluid-structure interaction	Van de Vosse	3	3
3S400	Biophysical techniques	De Jong	4	3
4B680	Heat transfer	Rindt	4	3
4K710	Micro fluidics put to work	Den Toonder	4	3
8W100	Numerical analysis of continua II	Oomens	4	3
8W320	Vesselmechanics	Rutten	4	3

Electives master track Molecular BioEngineering and Molecular Imaging (MBEMI) (2012-2013)

Semester A

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
0EM60	Perspectives on medical technology [4)]	Kraemer	1	3
6KM22	Physical organic chemistry	Janssen	1	3
8N060	Molecular imaging	Nicolaij	1	3
8N090	Nuclear magnetic resonance	Prompers	1	3
8N120	Radiation physics [1)]	Ten Eikelder	1	3
8N140	Uitwisseling en homeostase	Prompers/Dankers	1	3
8S140	Bio-organische chemistry	Sijbesma	1	3
8S170	Drug discovery	Brunsveld	1	3
8S180	Pharmacologie	Brunsveld	1	3
3F230	Clinical physics: measuring and monitoring of vital functions	Wijn	2	3
3S390	Biosensors for medical diagnostics	Van Ijzendoorn	2	3
6KM17	Advanced organic chemistry	Sijbesma	2	3
8B080	Biomaterials	Koole	2	3
8H010	New developments in fluorescence microscopy on living tissues [1) 2)]	Van Zantvoort	2	3
8N080	Introduction MRI [1)]	Strijkers	2	3
8N130	Radioisotopes and ionizing radiation in biochemical technology [1)]	Gruell	2	3
8S070	Clinical chemistry	Vader	2	3
8S080	Protein engineering	Merkx	2	3

Semester B

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
3F190	Clinical MRI	Wijn	3	3
8N020	Physiological NMR	Nicolaij	3	3
8N100	Agents for molecular imaging and therapy	Gruell	3	3
8S060	Capita selecta laboratory medicine	Vader	3	3
0AM90	Let's make humans better: enhancement, technology & transhumanism [4)]	Kingma	4	3
6KM43	Advanced stereochemistry	Palmans	4	3
8N110	Advanced MRI	Strijkers	4	3

CURSUSSEN BMT

Code	Vaknaam	Verantwoordelijk docent	kwart	EC
8G020	Course instrumental analysis	Van Genderen	2 en 4	3
8S090	Course synthetic skills	Spiering	4	3
8S130	Course molecular and cellular biological	Liefde – De Beest	1 en 4	3

Studiepunten (EC) op basis van European Credit Transfer System (ECTS)

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Number of enrolled students and diplomas for the various study years

	No. enrolled old style students	No. enrolled Bachelor students	No. enrolled BME Master's students	No. enrolled ME Master's students	Total No. enrolled students	No. diplomas Bachelor	No. diplomas Master BME	No. diplomas Master ME
2005/2006	20	301	53	11	385	54	4	1
2006/2007	15	371	94	27	507	59	49	9
2007/2008	3	352	92	41	488	58	38	17
2008/2009	1	346	108	34	489	76	46	18
2009/2010	-	326	109	48	483	29	43	13
2010/2011		335	103	38	476	57	38	13

Bachelor's programme

Intake in Bachelor's programme, VSNU numbers

Cohort year	**First year programme**	**Directly from High School**	**Total**	
	Total	Total	Male	Female
2010	86	74	64%	36%
2009	98	92	68%	32%
2008	85	73	73%	27%
2007	89	76	67%	33%
2006	112	104	69%	31%
2005	95	84	77%	23%

Propaedeutic yield for students directly from High School (VWO); TU/e numbers, cohort size per 1/12

Cohort	**N**	**In 1 year**		**In 2 years**		**After 2 years**	
2010	70	**23%**	16	-	-	-	-
2009	88	**15%**	13	**44%**	39	-	-
2008	71	**10%**	7	**39%**	28	**59%**	42
2007	72	**18%**	13	**49%**	35	**67%**	48
2006	95	**17%**	16	**40%**	38	**57%**	54
2005	80	**9%**	7	**40%**	31	**61%**	48

Propaedeutic yield for re-enrolled students i.e., those that actually continue their studies

Cohort	**N**	**In 1 year**		**In 2 years**		**After 2 years**	
2010	49	**31%**	15	-	-	-	-
2009	51	**25%**	13	**72%**	39	-	-
2008	50	**14%**	7	**56%**	28	**84%**	42
2007	52	**25%**	13	**67%**	35	**92%**	48
2006	67	**24%**	16	**57%**	38	**81%**	54
2005	60	**12%**	7	**52%**	31	**80%**	48

VWO intake, TU/e numbers

Number of Bachelor diplomas (within parentheses: cum laude)

	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Bachelor	54 (3)	59 (3)	58 (3)	76 (6)	29 (2)	57 (4)

Bachelor yield for students from VWO; VSNU numbers

Cohort	N	In 3 years	In 4 years	In 5 years	In 6 years	> 6 years
2008	73	11%				
2007	76	8%	37%			
2006	104	17%	27%	38%		
2005	84	20%	44%	48%	50%	
2004	82	17%	29%	41%	48%	52%
2003	77	14%	26%	38%	50%	54%

Bachelor yield for re-enrolled students (from VWO); VSNU numbers

Cohort	N	Percentage cohort	In 3 years	In 4 years	In 5 years	In 6 years	> 6 years
2008	54	74%	15%				
2007	57	75%	11%	49%			
2006	72	69%	25%	39%	54%		
2005	63	75%	27%	59%	63%	67%	
2004	59	72%	24%	41%	58%	66%	73%
2003	50	65%	22%	40%	58%	76%	82%

Average grades per graduation year

Graduation year	BMT	BMT with final project	
	Courses	Courses	Thesis
2010-2011	7.2	7.4	8.0
2009-2010	7.3		
2008-2009	7.2		
2007-2008	7.3		
2006-2007	7.3		
2005-2006	7.4		

Master's programme Medical Engineering

Intake in Master ME

Cohort	TU/e	Other Univ. NL	HBO [1,2]	University BSc Intl.	Total		
					Total	M (%)	F (%)
2010	16	0	2	0	18	60	40
2009	20	0	1	0	21	55	45
2008	14	0	2	0	16	60	40
2007	17	3	2	0	22	70	30
2006	23	3	6	0	32	54	46
2005	24	0	5	0	29	50	50

VSNU numbers; only main registrations

[1] Students from HBO admitted to the programme after a pre-MSc.

[2] TU/e numbers.

Numbers of graduates and their distinction

	Master of Science				
Study year	**Total**	**Cum laude**		**With Great Distinction**	
2010	13	2	15%	1	8%
2009	13	0	0%	1	8%
2008	18	0	0%	1	6%
2007	17	1	6%	1	6%
2006	9	2	22%	1	11%

Duration of total study in months

Graduation year	BSc + MSc (ME)
2010-2011	70.1
2009-2010	82.9
2008-2009	75.7
2007-2008	69.3
2006-2007	72.0

Master's programme Biomedical Engineering

Intake in Master BME: VSNU numbers; only main registrations

Cohort	TU/e	Other Univ. NL	HBO [1,2)]	University BSc Intl.	Total		
					Total	M (%)	F (%)
2010	47	0	2	8	57	60	40
2009	30	1	3	4	38	66	34
2008	38	0	0	6	44	73	27
2007	42	0	4	5	51	66	34
2006	47	1	1	5	54	55	45
2005	64	0	1	0	65	66	34

[1)] Students from HBO admitted to the programme after a pre-MSc.
[2)] TU/e numbers.

Number of graduates

	Master of Science				
Study year	**Total**	**Cum laude**		**With Great Distinction**	
2010	**38**	**2**	**5%**	**3**	**8%**
2009	**43**	**1**	**2%**	**11**	**26%**
2008	**46**	**7**	**15%**	**5**	**11%**
2007	**38**	**6**	**16%**	**9**	**24%**
2006	**49**	**6**	**12%**	**18**	**37%**

Duration of total study of graduates in months

Graduation year	BSc + MSc (BME)
2010-2011	79.7
2009-2010	79.5
2008-2009	80.2
2007-2008	83.3
2006-2007	76.5

Teacher-student ratio achieved

More than 40 staff members are available for education, with a high participation of full and associate professors in the Bachelor's phase. The staff has a ratio of 40%/40%/20% for

education, research, and managerial tasks. There are over 90 PhD students. They support our staff in the education process especially during the projects, internships and graduation projects.

At present, the full *Bachelor's programme Biomedical Engineering* reached a stable level of enrolled students of about 480. The Bachelor's programme comprises about 330 students. The overall result is a good ratio of 1 fte permanent staff to 15-20 students or 1 fte education staff per 27 students.

At present, the *Master's programme Medical Engineering* comprises about 20 students in the first year and about 20 students in the graduation project phase. This roughly implies that for each student there is about one PhD student available to share the research.

At present, the *Master's programme Biomedical Engineering* comprises about 50 students in the first year and about 50 students in the graduation project phase. This implies that for each student there is about one PhD student available to share the research.

Average amount of face-to-face instruction per stage of the study programme

Distribution of student's education activity in hours over the three years, Bachelor's programme

	Lectures	Guided self-study	Self-study	Experimental work	Reporting	Total
Year 1	216	336	1056		72	1680
Year 2	216	336	1056		72	1680
Year 3	216	108	948	336	72	1680
Total	648	780	3060	336	216	5040

Appendix 6: Programme of the site visit

10 October 2012

09.00 – 11.00:	**Start meeting**
11.00 – 11.30:	**Reviewing documents**
11.30 – 12.00:	**Professional Field Experts** René Aarnink MSc PhD (department head minimally Invasive Healthcare, Philips Research) Bas Dekkers BSc (business unit manager, Enter Technology Jürgen de Hart MSc PhD (director Hemolab BV)
12.00 – 13.00:	**Management** Prof.dr. Peter Hilbers (dean) Prof.dr. Klaas Nicolaij (vice-dean) Prof.dr. Dick Slaaf (self evaluation committee) Mr. Rob Debey (managing director) Dr.ir. Marcel van Genderen (director of education) Ir. Rob van der Heijden (education coordinator) Niels Dekkers (student member department board)
13.00 – 13.45:	**Lunch** **Consultation hour (not used)**
13.45 – 14.30:	**Students Bachelor Programme BMT** Marieke van Driel (fourth year student) Lisanne Kok (second year student) Lenne Lemmens (second year student) Meike Kleuskens (second year student) Ronald van der Meer (fourth year student) Nick van Osta (first year student) Laura Vergoossen (third year student) Dorien Verschuren (fourth year student) Marc Vervuurt (first year student)
14.30 – 15.15:	**Teachers Bachelor Programme BMT** Prof.dr. Keita Ito (teacher) Prof. dr. Peter Hilbers (teacher) Prof. dr. K. Nicolaij (teacher) Dr.ir. Peter Bovendeerd (case coordinator / teacher) Dr.ir. Natal van Riel (case coordinator / teacher) Dr. Jeanine Prompers (case coordinator / teacher) Dr. Anna Vilanova Bartroli (case coordinator / teacher) Dr.ir. Marcel van Genderen (director of education / teacher) Ir. Rob van der Heijden (education coordinator / DCL coordinator)
15.15 – 15.30:	**Break**

15.30 – 16.15: **Students Master Programme biomedical engineering / Medical Engineering**
Simone Booij (student biomedical engineering)
Alexander Colditz (student biomedical engineering)
Marijke Dermois (student biomedical engineering)
Wouter Gevers (student biomedical engineering)
Jolien Pas (student biomedical engineering)
Jürgen Schill (student biomedical engineering)
Ellen Schmitz (student Medical Engineering)
Björn Stemkens (student Medical Engineering)
Siem Wouters (student biomedical engineering)

16.15 – 17.00: **Teachers Master Programme biomedical engineering / Medical Engineering**
Prof.dr.ir. Bart ter Haar Romeny (biomedical engineering/Medical Engineering)
Prof.dr.ir. Frans van de Vosse (biomedical engineering/Medical Engineering)
Prof.dr. Bert Meijer (biomedical engineering)
Prof.dr. Holger Grüll (biomedical engineering)
Dr. René van Donkelaar (biomedical engineering)
Dr.ir. Cees Oomens (biomedical engineering)
Dr.ir. Bart Markvoort (biomedical engineering)
Prof.dr. Tammo Delhaas (Medical Engineering)
Dr. Chris Aarts (Medical Engineering)
Dr.ir. Huub ten Eikelder (biomedical engineering)

17.00 – 17.45: **Alumni**
Dr. ir. Ellen Brunenberg (medical physicist, in training)
Ir. Marloes Damen (clinical physicist in training Maxima Medical Center)
Ir. Beatrijs van der Hout (PhD Maxima Medical Center)
Ir. Irene Kaashoek (researcher TNO)
Dr. ir. Lambert Speelman (post doc Erasmus Medical Center)
Dr.ir. Marcel van 't Veer (qualified mechnical engineer, Catharina Hospital)
Ir. Kim van de Ven (clinical researcher Philips)

11 October 2012

08.30 – 09.00: **Guided Tour**
Guided tour through lab Tissue Engineering and lab Biomodelling and Imaging (by prof.dr. Peter Hilbers)

09.00 – 09.30: **Programme Committee**
Prof.dr.ir. Frans van de Vosse (chair)
Dr.ir. Bert van Rietbergen (staff member)
Dr.ir. Gustav Strijkers (former staff member)
Ir. Tom Schreurs (staff member)
Marieke van Driel (student member / education officer Protagoras)

	Rob Driessen (student member) Evi van den Heuvel (student member) Marina Sabbadini (student member) Renske van der Wal (student member)
09.30 – 10.15:	**Examination Committee** Prof.dr.ir. Luc Brunsveld (Chair) Dr. Maarten Merkx (staff member) Dr.ir. Jacques Huyghe (staff member) Drs. Irene Jansen-van de Lagemaat (adviser)
10.15 – 11.00:	**Preparation final meeting Management**
11.00 – 11.45:	**Final conversation Management** Prof.dr. Peter Hilbers (dean) Prof.dr. Klaas Nicolaij (vice-dean) Prof.dr. Dick Slaaf (self evaluation committee) Mr. Rob Debeij (managing director) Dr.ir. Marcel van Genderen (director of education) Ir. Rob van der Heijden (education coordinator) Niels Dekkers (student member department board)
11.45 – 13.30:	**Committee preparation interim report / Lunch**
13.30 – 14.15:	**Oral Report and Informal Closing and Drinks**

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bachelor	Master Biomedical Engineering	Master Medical Engineering
0649706	0484591	0580348
0650791	0568660	0586905
0652177	0571976	0589798
0652442	0571992	0589952
0653358	0588437	0592287
0653896	0590406	0608247
0653956	0593886	0609104
0655065	0597096	0609286
0657438	0597867	0609631
0658215	0598580	0612126
0658565	0606926	0614033
0658792	0612438	0615703
0660348	0616181	0615806
0661075	0635790	0617590
0661318	0730519	0662699

During the site visit, the committee studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

- Reports of Examination Committee
  - minutes 2010 / 2011 / 2012
  - annual reports 2009 / 2010 / 2011
- Reports of Programme Committee
  - minutes 2010 / 2011 / 2012
- Selection of Exams
- Obligatory literature (available in CIC)
- Summary evaluation results / Quality care
- Annual Reports Educational Institute BME
  - 2005 - 2006
  - 2006 - 2007
  - 2007 - 2008
  - 2008 - 2009
  - 2009 - 2010
  - 2010 - 2011
- External internship reports (6):
- Students Satisfaction Surveys

- News concerning Biomedical Engineering
- Results Alumni Surveys ME
- Results Alumni Surveys BME

- Feedback Exit interviews with graduate students
  - Period 2009 - 2011
  - Period 2011 - 2012

- Documentation concerning Study Association "Protagoras"
  - Annual report 2010-2011
  - Protatype (students magazine)

Appendix 8: Declarations of independence

nvao

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Jos Vander Sloten

HOME ADDRESS: Langstraat 62
3190 Boortmeerbeek
Belgium

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

BSc x MSc TU Twente

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

nvao

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Boortmeerbeek DATE: 11/9/12

SIGNATURE:

Q309

nvao

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Johannes J. Struijk

HOME ADDRESS: Aalborgvej 11
9575 Terndrup
Denmark

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

Biomedical Technology B.Sc.
Biomedical Engineering M.Sc.

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

University of Twente

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

nvao

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Aalborg DATE: 10 sept. 2012

SIGNATURE:

nvao

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Jos A E Spaan

PRIVÉ ADRES:

C. Boyerlaan 10
1324 LH Almere

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Biomedical Engineering

AANGEVRAAGD DOOR DE INSTELLING:

TUE

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN.

nvao

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Eindhoven DATUM: 9 oktober 2012

HANDTEKENING:

nvao

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Richard Reilly

HOME ADDRESS: Trinity College Dublin, Dublin 2, Ireland
Home address: 93 Mayfield Road
Ballybrack
Dublin 4, Ireland

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

University of Twente BSc and MSc Biomedical Engineering

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION

University of Twente

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

nvao

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: University of Twente DATE: 13/9/2012

SIGNATURE:

nvao

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Jan-Ytse de Boer

PRIVÉ ADRES: Witbreuksweg 377-010
7522-ZA
Enschede

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN D OPLEIDING:

Master Biomedical Engineering

AANGEVRAAGD DOOR DE INSTELLING:

T.U. Delft

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN ME BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEI VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VA DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEI BEÏNVLOEDEN;

nvao

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Enschede

DATUM: 11 mei 2012

HANDTEKENING:

Jde Boer

nvao

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Linda van der Grijpaarde

HOME ADDRESS

Opwierderweg 150
Oppingedam

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

Biomedical Engineering

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

University Twente, TU Delft, TU/e

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

nvao

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS;

CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO;

HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Oppingedam

DATE: 21 November 2012

SIGNATURE