

***Programme-specific appendix  
of the Biomedical Engineering (BME)  
Master's Programme  
Course and Examination Regulations  
(art. 7.13 and 7.59 WHW)***

**Table of contents**

Preamble	.....	2
Article 1	Programme objectives .....	2
Article 2	Programme learning outcomes .....	2
Article 3	Admission commission .....	6
Article 4	Admission to the programme .....	6
Article 5	Standard Master's programme.....	7
Article 6	Admission requirements for students with a university Bachelor's degree.....	8
Article 7	HBO-student study programme.....	8
Article 8	Requirements for HBO-students .....	9
Article 9	Internship .....	9
Article 10	Master's final project.....	10
Article 11	Transitional regulations.....	10
Article 12	Safety.....	10
Article 13	Practical exercises.....	10
Article 14	Sequence of units of study.....	10
Article 15	Flexible programme.....	11
Article 16	Student Counselling.....	11
Article 17	Inception date and amendments.....	11

Reference: TNW100003/vdh  
Date: 26<sup>th</sup> March 2010

## Preamble

- a. The rules in this appendix apply to the full-time Biomedical Engineering Master's programme (Croho-number 66226).
- b. Together with the General Section (TNW100001/vdh) and the Biomedical Board of Examiners Rules (TNW 100008/vdh), this appendix constitutes the programme part of the student statute, including the course and examination regulations of the Biomedical Engineering Master's programme of the Faculty of Science and Technology at the University of Twente.
- c. In the event of disagreement, the Dutch appendix and not this English version of this appendix is legally-binding.
- d. The Act refers to the Higher Education and Research Act (WHW).

## Article 1 Programme objectives

The aim of the Biomedical Engineering Master's programme is to enable students with a Biomedical Engineering or equivalent Bachelor's degree to gain more in-depth knowledge within a specific sub-area of the broad biomedical technological discipline, taking into account the specific competencies and interests of the individual student. Students' final qualifications can differ, but in any case include the competencies stated below:

A graduate with a Master of Science in Biomedical Engineering (BME):

1. Is specialised in a specific field of Biomedical Engineering;
2. Has the knowledge and skills to conduct research;
3. Has design skills;
4. Has a scientific approach;
5. Has intellectual knowledge;
6. Is capable of working and communicating with specialists, working in the chosen track and other interested parties;
7. Has the ability to integrate insights within medical and social contexts.

## Article 2 Programme learning outcomes

(k = knowledge, s= skill, a= attitude)

A graduate with a Master of Science in BME:

1. Is specialised in a specific field of Biomedical Engineering; a graduate with a Master of Science in BME is familiar with current scientific knowledge and has the competency to expand this by means of studying.
  - 1a. Is proficient in aspects of the specific biomedical-technological discipline, touching on cutting edge knowledge (the latest theories, methods, techniques, current issues). [ks]
  - 1b. Actively looks for structure and the relation between Biomedical Engineering and relevant disciplines, such as physics, mathematics, technology, biology, physiology and medicine. [ksa]
  - 1c. Possesses knowledge of and a degree of skill in how the pursuit of knowledge, theory-formulation and model-formulation occur in a specific field of Biomedical Engineering. [ks] Has the skill and attitude to apply these methods independently within the context of more advanced ideas or applications. [ksa]
  - 1d. Possesses knowledge of and a degree of skill in how interpretations (of texts, data, problems, results) occur in Biomedical Engineering. [ks] Has the skill and attitude to apply these methods independently within the context of more advanced ideas or applications. [ksa]
  - 1e. Possesses knowledge of and a degree of skill in how experiments, data-collection and simulations occur in Biomedical Engineering and related disciplines. [ks] Has the skill and attitude to apply these methods independently within the context of more advanced ideas or applications. [ksa]

- 1f Possesses knowledge of and skill in how decision-making occurs in Biomedical Engineering. Has the skill and attitude to apply these methods within the context of more advanced ideas or applications. [ksa]
- 1g. Can reflect on standard methods and their assumptions; can question these; can propose modifications and estimate their implications. [ksa]
- 1h. Is capable of detecting own gaps in knowledge and to revise and expand his/her knowledge by means of studying.
- 2. Possesses the knowledge and skill to conduct research. A graduate with a Master of Science in BME has the competency to acquire new scientific knowledge by means of research. Research in this sense entails: goal-oriented and methodical development of new knowledge and new insights.
  - 2a. Is capable of reformulating badly-structured research problems and also takes into account system limits. Is able to defend this new interpretation regarding the parties involved. [ksa]
  - 2b. Is observant and has the creativity and capability to discover certain new relations and viewpoints in ostensibly trivial matters. [ksa]
  - 2c. Is able to formulate a research plan and carry it out independently. [ks]
  - 2d. Chooses the appropriate level of abstraction, taking into account the process phase of the research problem. [ksa]
  - 2e Is able and has the appropriate attitude to include, where necessary, other disciplines in his/her own research. [ksa]
  - 2f. Is aware of the variability of the research process due to external circumstances or evolving insight. [ka] Is able to cope with this variability, and on the basis of this, is able to steer the process where necessary. [ksa]
- 2g. Is capable of assessing the scientific value of research within the field of Biomedical Engineering. [ksa]
- 2h. Is able to contribute independently to the development of scientific knowledge in one or various sub-areas of Biomedical Engineering [ks].
- 3. Will sometimes possess design skills. Besides research, some graduates with a Master of Science in BME will also carry out design projects. This discipline will especially play an important role in the Human Function Technology track. This applies less to the Molecular, Cellular and Tissue Engineering track. Designing is a synthetic activity focussing on the realisation of modified artefacts or systems, with the aim of creating values in accordance with requirements and wishes stipulated in advance.
  - 3a Is capable of reformulating badly-structured research problems of a complex nature and also takes into account system limits. Is able to defend this new interpretation regarding the parties involved. [ksa]
  - 3b. Possesses creative and synthetic skills with regard to biomedical design problems. [ksa]
  - 3c. Is able to formulate a design plan and carry it out independently. [ks]
  - 3d. Chooses the appropriate level of abstraction, taking into account the process phase of the design problem. [ksa]
  - 3e. Is able to and has the appropriate attitude to include, where necessary, other disciplines in his/her own design. [ksa]
  - 3f. Is able to cope with the variability of the design process due to external circumstances or evolving insight. Is able to steer this process on the basis of this. [ksa]

- 3g. Is capable of formulating new research questions based on a design problem. [ks]
- 3h. Possesses the skill to make design decisions and to substantiate and systematically evaluate these. [ks]
- 4. Has a scientific approach. A graduate with a Master of Science in BME has a systematic approach - characterised by the development and use of theories, models and cohesive interpretations - has a critical attitude and has insight into the specific nature of science and technology.
- 4a. Is capable of detecting and adopting relevant developments. [ksa]
- 4b. Is able to view existing theories, models or interpretations critically in the Biomedical Engineering sub-area of the selected track [ksa]
- 4c. Possesses great skill in and affinity with using, developing and validating models; is able to consciously choose between modelling methods. [ksa]
- 4d. Has insight into the specific nature of science and technology (objective, methods, similarities and differences between scientific fields, nature of laws, theories, explanations, the role of experiments, objectivity, etc.). And possesses knowledge in this area of current discourse. [k]
- 4e. Has insight into scientific practice (research systems, relation with clients, publication systems, importance of integrity, etc.). And possesses knowledge in this area of current discourse. [k]
- 4f. Is capable of adequately documenting research results and designs with the aim of contributing to knowledge development in Biomedical Engineering and beyond. [ksa]
- 5. Possesses intellectual skills. A graduate with a Master of Science in BME is competent in reasoning, reflecting and forming an opinion. These are skills that are acquired or improved within the context of a discipline and are subsequently generically applicable.
- 5a. Is able to reflect on his/her own thoughts, decisions and acts independently, and steer this accordingly. [ksa]
- 5b. Is capable of recognising fallacies. [ks]
- 5c. Is able to recognise methods of reasoning (induction, deduction, analogy, etc.) within the discipline and apply them. [ksa]
- 5d. Is able to ask adequate questions and has a critical-constructive attitude with regard to analysing and solving complex real-life biomedical problems. [ksa]
- 5e. Is able to form a rational opinion in the case of incomplete or irrelevant data, taking into account the manner in which this data was established. [ks]
- 5f. Is able to adopt a position with respect to a scientific argument in Biomedical Engineering and is able to evaluate it critically. [ksa]
- 5g. Possesses basic numerical skills and has an understanding of orders of magnitude. [ksa]
- 6. Is capable of working and communicating with specialists working in the chosen track and other interested parties. A graduate with a Master of Science in BME has the competency to be able to work with and for others. This requires adequate interaction, sense of responsibility and leadership, but also good communication with colleagues and others. He/she is also capable of participating in a scientific or public debate.
- 6a. Is able to communicate in written English about research and solutions for problems with colleagues, non-colleagues and other parties involved. [ksa]
- 6b. Is able to communicate in oral English about research and solutions for problems with colleagues, non-colleagues and other parties involved. [ksa]

- 6c. Idem as above (oral and written), but in a second language. [ksa]
- 6d. Is able to debate about Biomedical Engineering and the position of Biomedical Engineering in society. [ksa]
- 6e. Is characterised by professional conduct. This entails: drive, reliability, commitment, accuracy, perseverance and independence. [ksa]
- 6f. Is able to work in complex projects: possesses pragmatism and sense of responsibility; is able to cope with limited sources; is able to cope with risks; is able to make compromises. [ksa]
- 6g. Is capable of working in a multidisciplinary team with a great diversity of disciplines. [ksa]
- 6h. Is able to assume the role of team leader. [ks]
- 7. Has the ability to integrate insights within medical and social contexts in his/her work. Life-science and technology are not isolated and always have a temporal and social context. Views and methods have their origin; decisions have temporal social consequences. A graduate with a Master's of Science in BME is aware of this and has the competency to integrate these insights in his/her scientific work.
  - 7a. Understands relevant (internal and external) developments in the history of Biomedical Engineering. This includes the interaction between the internal development (of ideas) and external (social) development. [ks] Integrates aspects of these in scientific work. [ksa]
  - 7b. Is capable of analysing and discussing the social consequences (economic, social and cultural) of new developments in relevant disciplines with colleagues and others. [ks] Integrates these consequences in scientific work. [ksa]
  - 7c. Is capable of analysing the consequences of scientific thought and practice on the environment and sustainable development. [ks] Integrates these consequences in scientific work. [ksa]
  - 7d. Is capable of analysing and discussing the ethical and normative aspects of the effects and assumptions of scientific thought and actions with colleagues and others. [ks] Integrates these ethical and normative aspects in scientific work. [ksa]
  - 7e. Chooses his/her place as a professional in society. [ksa]

### **Article 3 Admission commission**

1. The Dean of the TNW Faculty establishes an admissions commission for the purpose of admitting students to the Master's programme for whom the Master's programme in question is not a follow-on Master's as stipulated in article 7.30a of the Act.
2. The commission, as stated in clause 1, has been authorised by the Executive Board (reference S&C/387.191/lk) to admit or reject applicants.
3. The admission commission consists of a minimum of two members, including:
  - a. the Programme director;
  - b. the professor or a delegated representative of the Chair where the student wishes to graduate.
  - c. in the case of international students, the internationalisation coordinator;
  - d. in the case of HBO (university of applied sciences)-students, the HBO-coordinator;The Programme Director is the chairperson of the admission commission.  
If the chairperson of the commission deems it necessary, the programme coordinator and/or study advisor and/or board of examiners secretary may be added to the commission.  
The admission commission may ask the board of examiners for advice.

### **Article 4 Admission to the programme**

1. Direct admission to the programme can be obtained by:
  - a. A Biomedical Engineering Bachelor's degree from the University of Twente, Eindhoven University of Technology, or the BMT-specialisation as part of the University of Groningen's Life Sciences studies.
  - b. Proof of admission to the programme, issued by the admission commission.
2. Admission to the programme under certain conditions may be obtained by:
  - a. Students who have an Advanced Technology, Electrical Engineering, Physics or Applied Physics, Chemistry or Chemical Engineering, Applied Mathematics or Mechanical Engineering Bachelor's degree from a Dutch university. In this case, clauses 3 to 5 are applicable. The specific definitions and requirements are stipulated in article 6 of this programme appendix.
  - b. Students who have an HBO-diploma from a programme that is relevant to the Biomedical Engineering discipline. In this case, clauses 3 to 5 are applicable. The pre-Master's programme determined by the board of examiners and the Master's programme for these students are stipulated in article 7 of this programme appendix. The requirements that these students must meet during their first study year are stipulated in article 8 of this programme appendix.
3. When assessing a request for admission to the Master's programme, the admission commission may require that certain subjects are passed before proof of admission to the Master's programme is issued.
4. When issuing proof of admission to the Master's programme, the admission commission may award exemptions from certain components of the Master's, with the exception of the final project.
5. When issuing proof of admission to the Master's programme, the admission commission may stipulate conditions to the student for the specific Master's programme content and determine that admission is only to a certain track.
6. Rulings referred to in clause 4 and 5 of this article made by the admission commission, require approval from the board of examiners.
7. Students who have a foreign degree must be able to demonstrate their proficiency in English, both oral and written. Proof that their score on a certified test meets the standard may be an admission requirement. Namely, a total score of 6.5 or higher on the IELTS test or a score of 90 or higher on the internet-based TOEFL test<sup>1</sup>. Students with a Bachelor's degree from countries

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<sup>1</sup> IELTS: International English Language Testing System; TOEFL: Testing of English as a Foreign Language; see the UT website regarding admission to the Master's programmes: <http://www.utwente.nl/admissionoffice/master/internationaal/>

with English only as the language of instruction in higher education<sup>2</sup> are exempted from this language requirement.

8. For students with a foreign degree - who under the conditions as referred to in clauses 3 and 5 of this article are considered admissible to the Master's programme, but are not capable of taking Dutch subjects - the formulation of an individual pre-Master's and homologation programme, adapted to the track in which the student in question wishes to graduate, applies in this case.

## Article 5 Standard Master's programme

1. The BME Master's programme has two main specialisations (called 'tracks'), namely:
  - a. Molecular, Cellular and Tissue Engineering (MCTE)
  - b. Human Function Technology (HFT)
2. Besides Human Function Technology as its main specialisation, this track also has two differentiations (sub-tracks): Health Care Technology (HFT-Care) and Biomedical Physics (HFT-BMPH).
3. The BME Master's programme comprises 120 ECs, of which 15 and 45 ECs, respectively, are reserved for an internship and a Master's final project. Per track or sub-track, there are 3 compulsory subjects (15 ECs). Additionally, 45 ECs must be allocated to electives. See table 1. In this case, a minimum of 10 ECs for biomedical subjects (M-courses) and a minimum of 15 ECs for biomedical engineering subjects (B-courses) must be included in the electives course list of 45 ECs. Students may add engineering subjects (E-courses) and special subjects (S-courses) to the course list. To choose B and M-courses, students can make use of the lists, used by the research groups, with the so-called 'recommended courses' and the list with BME subjects (to be found in the study guide and on the website <http://www.utwente.nl/bme/education>).
4. The course list must be approved before the BME Master's can be started.
5. The electives are selected in consultation with the final project commission's chairperson.
6. The course list requires approval by the final project commission's chairperson and the board of examiners.
7. Approval is required from the board of examiners for the inclusion of subjects in a student's course list that are not included in the regular BME curriculum.

**Table 1 Standard BME Master's programme**

	ECs
Compulsory subjects (different per track or sub-track)	15
Electives (requirements in article 5, clause 3)	45
Internship	15
Master's final project	45
<i>Total</i>	120

**Table 2 Compulsory subjects for the MCTE track**

Subject code	Name	ECs
193640040	Tissue engineering	5
193640020	Biophysical techniques and molecular imaging	5
193740020	Biomedical materials engineering I	5

**Table 3 Compulsory subjects for the HFT track**

Subject code	Name	ECs
191211310	Technology for the support of human functions	5
191150700	Integrative design of biomedical products	5
193524040	Non-invasive diagnostics	5

<sup>2</sup> List of countries can be found on <http://www.utwente.nl/admissionoffice/master/internationaal/> under General Admission Requirements.

**Table 4 Compulsory subjects for the HFT sub-track – Biomedical Physics**

Subject code	Name	ECs
191211310	Technology for the support of human functions	5
193640020	Biophysical techniques and molecular imaging	5
193524040	Non-invasive diagnostics	5

**Table 5 Compulsory subjects for the HFT sub-track – Care**

Subject code	Name	ECs
191211310	Technology for the support of human functions	5
191150700	Integrative design of biomedical products	5
191211470	Home care technology	5

**Article 6 Admission requirements for students with a university Bachelor's degree**

1. Students who have a Mechanical Engineering, Electrical Engineering, Chemical Engineering, Applied Mathematics, Physics or Chemistry Bachelor's degree from a Dutch university, may be admitted to the BME Master's programme. Additionally, the admission commission determines which Master's track or Master's tracks the student is admitted to. Admission is on the condition that students use part of their electives in the Master's programme in order to follow the homologation programme as stipulated in table 7. This condition made by the admission commission requires, according to article 4.6 of the programme appendix, approval from the board of examiners.

**Table 7 BME Homologation programme for students with a university (WO) and HBO Bachelor's degree**

Subject code	Name	ECs
192702000	Anatomy and physiology of movement	5
191350060	Structure and functioning of cells	5
192730110	Health care processes for BMT	2.5
192730550	Care and rehabilitation technology	2.5
<i>Total</i>		15

2. Students who have an Advanced Technology (AT) Bachelor's degree from the University of Twente, may be admitted to the BME Master's programme. Additionally, the admission commission determines which Master's track or Master's tracks this student may be admitted to and which pre-Master's is required for this. If the AT student has already included this programme in his/her course list for the AT Bachelor's examination, then the student is directly admissible. Admission can be on the condition that the student uses part of his/her electives in the Master's programme in order to follow the homologation programme as stipulated in table 7. The conditions made by the admission commission require, according to article 4.6 of the programme appendix, approval from the board of examiners.

**Article 7 HBO-student study programme**

1. Students must first follow a pre-Master's programme of 30 ECs. This comprises 15 ECs of electives. Additionally, a number of BMT subjects must be followed, which relate to the student's major. Moreover, students are granted permission to simultaneously do a part of the BME homologation programme (15 ECs, see article 6 of this appendix) and some subjects from the Master's programme.
2. Upon completion of the pre-Master's programme, students may be admitted to the BME Master's programme, whereby students are exempted from the internship (15 ECs).
3. The following requirements apply for admission:
  - a. Admission is valid for the track for which the pre-Master's was followed.
  - b. Students must include the homologation programme from table 7 stipulated by the board of examiners in their Master's programme.
  - c. A student's Master's programme must also meet the requirements stipulated for the standard Master's programme in the corresponding track (article 5 of this appendix).

**Table 8 Pre-Master's programme for students with an HBO Bachelor's degree**

Mathematics subjects		ECs
191512000	Calculus A	4
191512020	Calculus B	3
191512040	Calculus C	3
191512060	Linear Algebra A	3
191512080	Linear Algebra B	2
<i>Sub-total</i>		15
Specialisation-specific pre-Master's subjects		Max. 15
<i>Total</i>		Max. 30

**Article 8 Requirements for HBO-students**

1. Students who have been admitted in accordance with article 4.2b of this programme appendix to the pre-Master's and homologation programme, are given a pre-recommendation after the first term of being enrolled. This pre-recommendation is issued by the board of examiners, based on the HBO-coordinator's recommendations. For students who are admitted per 1<sup>st</sup> September, the pre-recommendation is issued at the latest in December; for students who are admitted per 1<sup>st</sup> February, the pre-recommendation is issued at the latest in June.
2. Students who have been admitted in accordance with article 4 of this programme appendix to the pre-Master's and homologation programme, are given a recommendation after 3 terms. For those students who are admitted per 1<sup>st</sup> September, the recommendation is issued at the latest in June; for students who are admitted per 1<sup>st</sup> February, the recommendation is issued at the latest in December.
3. Students who have passed all the subjects of the pre-Master's programme after three terms, will be given a positive recommendation.
4. Students who have not yet passed all the pre-Master's programme subjects are given a positive recommendation if they meet all the following requirements:
  - During the first three terms of being enrolled, a total of 30 ECs have been obtained;
  - During the first three terms at least 20 ECs of the pre-Master's programme have been obtained;
In all other cases, students will be given a negative recommendation.
5. A positive recommendation entails that students are granted permission to complete the pre-Master's and homologation programme and to continue with the corresponding Master's programme (see article 7 of this programme appendix). The definitions in article 13 of this programme appendix continue to apply in this case.
6. A negative recommendation entails that students may only do pre-Master's subjects and subjects in the homologation programme, and may not do other Master's subjects. This restriction comes into force in the term following the date on which the negative recommendation is issued. The restriction expires when all the pre-Master's subjects have been passed.
7. The recommendation is issued by the board of examiners.
8. In exceptional cases, the board of examiners may decide to make an exception to the aforementioned rules.

**Article 9 Internship**

The goal of the internship is to enable students, by carrying out an assignment in an external organisation, to gain experience in the future field of employment and to put into practice the knowledge and skills acquired thus far. This external organisation can be a medical institution, research institute, university or a biomedical company.

## **Article 10 Master's final project**

1. The goal of the project is to learn how to conduct independently a research project of a certain size and complexity.
2. The Master's final project is carried out in principle at one of the UT's biomedical Chairs.
3. The Master's final project is selected in consultation with the final project professor.
4. If external graduation has been opted for, this must occur under the responsibility of one of the BMT/BME programme professors.
5. Further definitions concerning the Master's final project can be found in the BME board of examiners Rules (TNW100008/vdh/JCA+JE).

## **Article 11 Transitional regulations**

1. If the study programme included in articles 5, 6 and 7 of this appendix is amended, or if one of the articles included in the general section or programme appendix is amended, the Programme Director will stipulate and publish transitional regulations.
2. The conditions which transitional regulations must meet are stipulated in article 29 of the general section.
3. The transitional regulations are published on the programme's website.

## **Article 12 Safety**

There are safety requirements for working in a laboratory. Students are obliged to inform themselves of these rules<sup>3</sup> and to adhere to them.

## **Article 13 Practical exercises**

It is not required to pass units of study that include practical exercises until after these practical exercises have been carried out.

## **Article 14 Sequence of units of study**

1. Before starting a unit of study, students must meet the prior knowledge requirements of that unit of study.
2. Students whose follow-on Master's programme is the Biomedical Engineering Master's programme (WHW art. 7.13, clause 3), may only begin the internship and final project examination sections if they have obtained the Biomedical Engineering (Crohonumber 56226) Bachelor's degree.
3. Students may only begin the final project if they have obtained a minimum of 65 ECs of the Master's programme.
4. Students who must follow a pre-Master's and/or homologation programme, may only begin the final project when they have completed this pre-Master's and/or homologation project. Only a maximum of 10 ECs of the rest of the programme may still be pending.
5. Before the final colloquium can be held, all other units of study need to have been passed.

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<sup>3</sup> See the 'Health & Safety and Environmental Regulations' ('Arbo- en Milieureglement') on <http://www.tnw.utwente.nl/intra/diensten/amh/> and the TNW laboratory practice group information on [http://www.tnw.utwente.nl/onderwijs\\_overig/practica/](http://www.tnw.utwente.nl/onderwijs_overig/practica/).

6. The board of examiners is authorised to dispense with the requirements stipulated in clauses 1 to 5 of this article, in the event that strict adherence to that which is stipulated would result in an unwarranted delay in study progress. Students can submit a request for this to the board of examiners.

#### **Article 15 Flexible programme**

Contrary to that which is stipulated in articles 5, 6 and 7 of this appendix, students can request permission from the board of examiners to follow a flexible programme as stipulated in art. 7.3c of the Act. The board of examiners assesses whether the programme corresponds to the programme's field, is cohesive and is of a sufficient standard in light of the programme's learning outcomes.

#### **Article 16 Student Counselling**

Upon enrolment in the programme, students will be assigned a study advisor. The study advisor has, on the one hand the responsibility to advise students individually, requested or not, regarding all aspects of their studies, and on the other hand, to inform the programme director of students' study progress.

#### **Article 17 Inception date and amendments**

These regulations will come into effect on 1<sup>st</sup> April 2010 and replace the regulations dated 13<sup>th</sup> September 2007.

**Enacted by the Dean of the Faculty, having obtained recommendations from the Faculty Council and programme commission.**

Enschede, dated 26<sup>th</sup> March 2010