

SECTION B - PROGRAMME-SPECIFIC SECTION ELECTRICAL ENGINEERING

CONTENTS

SECTION B - Programme-specific section ELECTRICAL ENGINEERING	1
9 General Provisions	2
Article 9.1 Definitions	2
10 Programme objectives and final attainment targets	2
Article 10.1 Aim of the programme	2
Article 10.2 Final qualifications	2
Article 10.3 Specialisations	2
11 Further admission requirements	3
Article 11.1 Programme specific admission requirements	3
Article 11.2 Pre-Master's programme for students from a Dutch University of Applied Sciences	4
12 Curriculum structure	4
Article 12.1 Composition of programme	4
Article 12.2 Compulsory units of study	5
Article 12.3 Philosophical and Societal courses	5
Article 12.4 Electives	5
Article 12.5 Homologation courses	5
Article 12.6 Internship	5
Article 12.7 Master's final project (master's thesis)	5
Article 12.8 Sequence of examinations	6
13 Planning, procedures and guidance during the Master's study	6
Article 13.1 Specialisation and subject combination	6
Article 13.2 Practical exercises	6
Article 13.3 Internship	7
Article 13.4 Master's final project	7
Article 13.5 Study counselling	7
14 Special opportunities	7
Article 14.1 Extended examinations	7
Article 14.2 Size and composition of the Flexible Degree programme	7
Article 14.3 Goal and requirements for Flexible Degree programmes	8
Appendix I - Specialisations and their compulsory courses	9

9 General Provisions

Article 9.1 Definitions

In addition to the definitions in Section A, Article 1.2, the following definitions are used in this Section B:

- a. **Electrical Engineering discipline:** The group of chairs of the Faculty of Electrical Engineering, Mathematics and Computer Science, taking part in the Electrical Engineering master's programme. They are mentioned in the table of Article 2.3.
- b. **Programme mentor:** a staff member, who is appointed by a chair to supervise students who joined the specialisation of this chair, until they start their Master's Final project.
- c. **Graduation committee:** the committee that supervises the master's final project and will carry out the assessment of the project.

10 Programme objectives and final attainment targets

Article 10.1 Aim of the programme

The programme aims to train master students in a spectrum of professional and personal competencies to enable them to expand their knowledge and methodology in design, through analysis and research, of innovative systems in the Electrical Engineering discipline.

Article 10.2 Final qualifications

A Master of Science in Electrical Engineering has the following competencies:

- A master has specialized advanced knowledge in at least one of the specialisations of Electrical Engineering as described below.
- A master has experience in working in industry-related projects and has acquired the ability to be effective in a multidisciplinary environment.
- A master is able to work at the frontier of research and design, and is innovative, contributing to breaking the frontiers of current technology or understanding.
- He/she defines his/her own design/research goals within the limits of his/her project, judges which parts of the problem need further analysis, carries out these analyses on an abstract level, proposes experiments and carries them out in a methodologically correct way.
- A master is able to understand, on a general level, areas adjacent to his/her own area of specialization and use this understanding in the context of his/her own work. He/she is able to appreciate new knowledge of other disciplines (if necessary also of non-technical areas) and to integrate this in his/her work.
- A master can carry responsibility as a leading member of a multidisciplinary design (or research/development) group and develops a broad scope, e.g., with respect to the economic aspects of his/her work, or the impact of technological innovation on society. He/she is a serious partner in discussions on aspects regarding the setting and societal environment of his/her work.

Compared to the bachelor level, a master has more specialized knowledge and abilities, more industrial experience and has skills to independently solve relatively complex problems.

Article 10.3 Specialisations

There is only one master's programme in Electrical Engineering and the field of specialization determines the contents of the programme. This specialisation is defined by the chair where the master thesis is carried out. The course programme corresponds to the specialisation. In this way graduates maintain a

broad Electrical Engineering qualification while being specialized in one of the specific fields. The field of specialization is indicated in the addendum of the degree diploma.

The following specialisations are defined in the Electrical Engineering programme:

Specialisation	Name of the chair	Abbreviation
lab-on-a-chip systems for biomedical and environmental applications	Biomedical and Environmental Sensorsystems	BIOS
neurotechnology and biomechatronics	Biomedical Signals and Systems	BSS
dependable integrated systems	Computer Architecture for Embedded Systems	CAES
robotics and mechatronics	Robotics & Mechatronics	RAM
communication networks	Design and Analysis of Communication Systems	DACS
integrated circuit design	Integrated Circuit Design	ICD
integrated optical microsystems	Optical Systems	OS
nanoelectronics	NanoElectronics	NE
computer vision and biometrics	Services, Cybersecurity and Safety	SCS
devices for integrated circuits	Semiconductor Components	SC
telecommunication engineering	Telecommunication Engineering	TE
micro sensors and systems	Micro Sensors and Systems	MSS

11 Further admission requirements

See Section A, Chapter 2, for general regulations regarding admission and enrolment

Article 11.1 Programme specific admission requirements

1. Admission to the Master's programme is possible for an individual who can demonstrate that he/she has the knowledge, understanding and skills as defined in the Attainment Targets of the Electrical Engineering Bachelor's programme of the University of Twente as described in Article A2 of the Programme Specific Part of the Education and Examination Regulations for the Bachelor's Degree Programme in Electrical Engineering.
2. Any individual who has obtained a Bachelor's degree in academic higher education on one of the following degree programmes meets the requirements referred to in paragraph 1:
 - a. Bachelor's programme Electrical Engineering at the University of Twente.
 - b. Bachelor's programme Electrical Engineering at the Technical University of Delft.
 - c. Bachelor's programme Electrical Engineering at the Technical University of Eindhoven.

- In addition to the language requirements stipulated in Section A, Article 2.2, the IELTS and IBT-TOEFL test results should satisfy requirements regarding the sub-scores. In case of an IELTS test all sub-scores should be at least 6.0. In case of an IBT-TOEFL test, all sub-scores should be at least 20.

Article 11.2 Pre-Master’s programme for students from a Dutch University of Applied Sciences
See Section A, Article 2.7, for general regulations regarding pre-master’s programmes.

- Students seeking admission on the basis of a Bachelor's degree awarded by a Dutch University of Applied Sciences must complete a bridging programme that includes the following subjects:

Code	Course	Study load (EC)
201500291	Calculus A	5
201500292	Linear Algebra	3
201500252	Digital Logic and Computer Organization	3
201500293	Calculus B	4
191231490	Linear Systems	6
191403070	Electricity & Magnetism HBO	5
201400279	Academic Research Skills	4
	Total	30

- Small changes in the programme are possible. The final programme should be announced to the students before the start of the programme.
- The programme assumes a minimal knowledge level VWO-B in mathematics and a VWO-level in English. (VWO being the Dutch preparatory secondary school for the universities).
- The conditions for admission to the master’s programme are as stipulated in Section A, Article 2.7.
- Students from a Dutch University of Applied Sciences may be allowed by the Admission Committee to follow the pre-Master’s programme as a part of their bachelor’s programme.

12 Curriculum structure

Article 12.1 Composition of programme

The curriculum consists of the following elements:

Year	EC	Topic
First	20	Compulsory units of study
	5..10	Philosophical and Societal courses
	30..35	Electives (Including possible homologation courses)
Second	20	Internship
	40	Master’s thesis project

Article 12.2 Compulsory units of study

Depending on the specialisation the set of compulsory courses may be fixed, or choices for compulsory courses will be made by the programme mentor after discussion with the student. For each specialisation the process of obtaining the compulsory courses is described in Appendix I.

Article 12.3 Philosophical and Societal courses

The units Philosophy of Engineering, Science (191616043) and Philosophy of Engineering, Ethics (201100137), worth 5 EC in total, are compulsory. Students can choose the other 5 ECs from non-technical units with a workload of at least 3 EC provided by any university. If students so desire, they can also complete 5 ECs in a technical subject. The examination committee can, in response to a written request from a student, allow 10 EC to be completed entirely or partially in some other way, in the event of grounds based on the student's previous education or other knowledge and experience obtained.

Article 12.4 Electives

Students shall select their elective units, after consultation with the programme mentor responsible for the chosen specialisation, from the following list:

- University of Twente: the master's subjects, offered by the studies in Electrical Engineering, Embedded systems, Computer Science, Applied Mathematics, Mechanical Engineering, Applied Physics, Nanotechnology and Sustainable Energy Technology.
- The Technical University in Delft and the Technical University in Eindhoven: the master's subjects, as listed for the study in Electrical Engineering.
- If subjects are included that do not fulfil the above, then permission will have to be obtained from the examination board.

The programme of electives requires approval by the programme mentor.

Article 12.5 Homologation courses

The rules for homologation courses are stipulated in Section A, Article 2.5.3.

Article 12.6 Internship

The general regulations for the internship are stipulated in section A, Article 3.8.

1. The Admission Committee can decide that the internship will be replaced by an individual research project in one of the research groups participating in the programme. The study load such a project is 10EC. The remaining 10EC of the internship will be spent to elective courses. This decision will be taken if during the bachelor's programme the student acquired substantial working experience from one or more internships and the student lacks project experience in a research group.

Article 12.7 Master's final project (master's thesis)

The general regulations for the master's final project are stipulated in section A, Article 3.7.

1. A student will carry out the final project subject to the accountability of the chair of the Electrical Engineering discipline responsible for the student's specialisation.
2. A description of the Master's project that a student will do must have been drawn up and approved by one of the members of the graduation committee.
3. The graduation committee is formed by a minimum of 3 persons, at least two of whom are full, associate or assistant professors of the chair, mentioned in paragraph 1. Of these two members, one

is a full or associate professor of the chair, mentioned in paragraph 1. The graduation committee shall also include one full, associate or assistant professor from a different chair than that under which the student is studying.

4. The graduation committee appoints one of its members as daily supervisor.
5. The Master's final project shall take place according to a planning as stipulated in section A, Article 3.7 and in Article 13.4.
6. The Master's project will normally be carried out within the chair, mentioned in paragraph 1. A Master's project may only be carried out external to one of the chairs of the Electrical Engineering discipline, subject to the explicit accountability of one of the chairs of the Electrical Engineering discipline. The chair concerned carries out supervision as described in the paragraphs of this Article and in Section A, Article 3.7. The programme director regards the project as being carried out by the chair concerned. If a project is carried out external to the chair, this should be reported in advance to the examination board.

Article 12.8 Sequence of examinations

1. There are no general conditions regarding the sequence in which the course units have to be followed. Prior knowledge requirements may be given in the individual course descriptions that can be found in the online study prospectus. The student should take them into account when planning the study programme.
2. In addition to section A, Article 3.8.2, the internship can only take place if the compulsory units and the unit Philosophy of Engineering (Ethics plus Science) have been completed.
3. Conditions for starting the master's thesis are stipulated in Section A, Article 3.7.

13 Planning, procedures and guidance during the Master's study

Article 13.1 Specialisation and subject combination

1. Before starting the master's study, students choose one of the specialisations of the programme and with this the chair of the Electrical Engineering discipline where the final project will be carried out. The student determines his package of subjects, together with the programme mentor of the chair, and draws up a schedule for attending the subjects, and for carrying out the internship and the final project.
2. The consultation referred to in Paragraph 1 results in a study plan that will be signed by both the student, and the programme mentor.
3. The package of subjects should be approved by the programme mentor and then submitted to the registry of the examination committee, at the latest by six months after the start of the master's study.
4. An alteration in the package of subjects may only be made with the programme mentor's agreement. If the package of subjects has already been submitted to the registry of the examination committee then any alterations should be reported to the registry immediately.

Article 13.2 Practical exercises

1. The study prospectus states which units include a practical exercise. If a unit involves a practical exercise, the examiner will give an assessment, by the latest, at the end of the period in which the subject is scheduled. This will be used to arrive at the final mark for that unit. If the results for the practical exercise are unsatisfactory, then the student has time available until the end of the next quarter to complete the exercise with a satisfactory result. If satisfactory results have still not been obtained, then the student can only obtain satisfactory results for the exercise by doing it over in full.

2. The assessments of the practical exercises can only be obtained after the student has participated in the exercise concerned.

Article 13.3 Internship

The rules for the internship are stipulated in Section A, Article 3.8

Article 13.4 Master's final project

1. The student and the daily supervisor of the chair must make an agreement about the starting and finishing dates of the Master's project.
2. The finishing date is obtained on the basis of a study plan, whereby time shall be set aside not only for the Master's project but possibly also for attending subjects and for taking resits.
3. The study plan must be approved by the supervisor and signed by the student.
4. No more than the nominal amount of time may be planned for working on the Master's project.
5. Students should report illness immediately to the secretariat of the chair. Time that is missed due to illness shall be added to the time available for the Master's project in the study plan.
6. The student should add any extra time, required for re-taking an interim examination, to the study plan and submit this to the daily supervisor for approval.
7. In the study plan the student and the supervisor should make appointments about how the student should spend his time during any academic holiday periods.
8. Sufficient time should be added to the study plan to compensate any delays that arise due to reasons beyond the student's control.
9. Immediately after the final date of the project as recorded in the study plan (including any adjustments as described in paragraphs 5 to 8), the graduation committee shall issue an opinion on how the project was carried out and determine the final mark.
10. If this final mark is a fail then the student must carry out a supplement to the project within a period of two months, after which the graduation committee will state its opinion again, which will lead at the most to a 6.
11. This new final mark will be regarded as the result of a resit.
12. If the result of a resit is a fail, then the student shall have to carry out a new Master's project.

Article 13.5 Study counselling

Regulations for study counselling are stipulated in Section A, Chapter 6.

14 Special opportunities

Article 14.1 Extended examinations.

1. Whosoever, either before or after passing the final examination of an EE master's study, has successfully taken interim examinations for units that are not or were not considered part of this study or a different study, but which could have been part of the said master's studies, will be examined, upon request, subject to the approval of the examination committee, in the form of an extended examination.
2. As proof that the extended examination has been completed successfully, the examination committee can, upon request, issue a separate statement.

Article 14.2 Size and composition of the Flexible Degree programme

General regulations for flexible degree programmes are stipulated in Section A, Article 3.5.

1. The flexible degree programme shall include at least one unit comparable with the Master's final project of the EE master's study; this unit shall have a workload of no less than 30 EC and no more than 50 EC.
2. The flexible degree programme can include a unit that is comparable with the internship of the EE master's study; this unit shall have a workload of no less than 20 EC and no more than 30 EC.
3. The flexible degree programme can include a short individual project amounting to 10 or 15 EC.
4. The examination committee can decide not to grant permission if both units referred to in paragraphs 2 and 3 exist in the proposed programme.

Article 14.3 Goal and requirements for Flexible Degree programmes

1. The goal of a Flexible Degree programme is to enable students to compile courses that go beyond the borders of course disciplines and in which various disciplines are represented in a well-balanced manner.
2. A Flexible Degree programme should have a well-defined goal.
3. A Flexible Degree programme should achieve a level comparable with that of the programme to which it is regarded as belonging, as evident from the following conditions:
 - a. the presence of units from the same programme phase of the various disciplines;
 - b. the presence of a final project, comparable with the final project of the programme to which the Flexible Degree programme is regarded as belonging.
4. A Flexible Degree programme should reflect inherent cohesiveness.
5. A Flexible Degree programme that can be regarded as belonging to the Electrical Engineering programme master's programme contains a substantial number, in the order of 20%, of the subjects for this programme.
6. An applicant who submits a Flexible Degree programme can include a number of electives, to be chosen later from a list attached to his request. These electives will have to be approved by the committee that will assess the final project.

APPENDIX I - SPECIALISATIONS AND THEIR COMPULSORY COURSES

Lab-on-a-chip systems for biomedical and environmental applications

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191211120	Lab on a Chip	5
191210720	Biomedical Signal Acquisition	5

Two more compulsory courses will be chosen by the programme mentor from the following list, after discussion with the student:

Code	Course	Study load (EC)
101210740	Material science	5
191211080	Systems engineering	5
191210730	Technology	5
191211300	Micro electro mechanical systems design	5
193400121	Nanofluidics	5

Neurotechnology and biomechatronics

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191211350	Neurophysiology	5
191211690	EM Statics	5
191210720	Biomedical Signal Acquisition	5
193810020	Advanced Techniques for Signal Analysis	5

Dependable integrated systems

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191210750	System-on-Chip Design	10

192130240	Embedded Computer Architectures 1	5
-----------	-----------------------------------	---

One more compulsory course will be chosen by the programme mentor from the following two, after discussion with the student:

Code	Course	Study load (EC)
192130092	Faulttolerant Digital Systems	5
191210760	Advanced Programming	5

Robotics and mechatronics

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191210770	Digital Control Engineering	5
191210760	Advanced Programming	5

Two more compulsory courses will be chosen by the programme mentor from the following six, after discussion with the student:

Code	Course	Study load (EC)
191211090	Real time software development	5
191211110	Modelling and Simulation	5
191211060	Modern Robotics	5
191210910	Image Processing and Computer Vision	5
201400427	Transducers Science	5
191211690	EMstatics	5

Communication networks

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
192620010	Mobile and Wireless Networking 1	5
192620300	Performance Evaluation	5
192654000	Network Security	5

One more compulsory course will be chosen by the programme mentor from the following ones, after discussion with the student:

201400177	Cloud Networking	Study load (EC)
192653100	Internet Management and Measurement	5
201400176	Dependable Networking	5
192620020	Mobile and Wireless Networking 2	5
201200006	Quantitative Evaluation of Embedded Systems	5
201400175	Social networks ^{*)}	5

*) If available

Integrated circuit design

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191210750	System-on-Chip Design	10
191210850	Advanced Analog IC-Electronics	5

One additional compulsory course will be chosen by the programme mentor from the following list, after discussion with the student:

Code	Course	Study load (EC)
191210870	Integrated Circuits and Systems for mixed signals	5
191211500	Wireless Transceivers Electronics	5
191210840	A/D Converters	5
191210860	Project Advanced Electronics	5
191211720	Microwave Techniques	5

Integrated Optical Systems

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
193400131	Nano-optics	5
191210880	Integrated optics	5

Two more compulsory courses will be chosen by the programme mentor from the following ones, after discussion with the student:

Code	Course	Study load (EC)
191210411	Electrodynamics	5
191210740	Materials science	5
191211080	Systems engineering	5
191210730	Technology	5
193520030	Non-linear optics	5
201300139	Laser physics	5
193530020	Advanced materials	5

Nanoelectronics

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
193400141	NanoElectronics	5
191211000	Advanced Semiconductor Devices	5
191210740	Materials Science	5
191210730	Technology	5

Computer vision and biometrics

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191210910	Image Processing and Computer Vision	5
201100254	Advanced Computer Vision and Pattern Recognition	5
191210900	Introduction to Biometrics	5

201300239	Machine Learning Short Course	5
-----------	-------------------------------	---

Devices for integrated circuits

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191210730	Technology	5
191211440	Integrated Circuit Technology	5
191211000	Advanced Semiconductor Devices	5

One additional compulsory course will be chosen by the programme mentor from the following list, after discussion with the student:

Code	Course	Study load (EC)
191210740	Material Science	5
191210750	System-on-Chip Design	10
191210850	Advanced Analog IC Electronics	5
193400141	Nanoelectronics	5

Telecommunication engineering

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191211030	Mobile Radio Communication	5
191210780	Modern Communication Systems	5
191211040	Electromagnetic Compatibility	5
201200231	Smart Antennas and Propagation	5

Micro sensors and systems

The following courses are compulsory for all students in the specialisation:

Code	Course	Study load (EC)
191211300	Micro Electro Mechanical Systems Design	5

191210930	Measurement Systems for Mechatronics	5
-----------	--------------------------------------	---

Two more compulsory courses will be chosen by the programme mentor from the following ones, after discussion with the student:

Code	Course	Study load (EC)
191210740	Materials Science	5
191131360	Design Principles for Precision Mechanisms	5
191210730	Technology	5
191211690	EMstatics	5