

**TEACHING AND EXAMINATION REGULATIONS
(TER)
(see Article 7.13 of the Higher Education and
Research Act)**

2013-2014

**MASTER'S PROGRAMME
EMBEDDED SYSTEMS**

**EINDHOVEN UNIVERSITY OF TECHNOLOGY
DELFT UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF TWENTE**

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The Board of the Mathematics and Computer Science Department of Eindhoven University of Technology, the Board of the Electrical Engineering, Mathematics and Computer Science Department of Delft University of Technology and the Board of the Electrical Engineering, Mathematics and Computer Science Department of the University of Twente

in view of articles 9.15, first paragraph, subparagraph a, 7.13, first and second paragraph, 9.38, subparagraph b, and 9.18, first paragraph, subparagraph a, of the Higher Education and Scientific Research Act of the Netherlands

having heard the recommendations of the involved Education Committees

with due observance of the consent of the involved Department Councils

hereby establishes

Teaching and Examination Regulations for the Embedded Systems Master's degree programme.

Section 1 - General

Article 1 – Definitions of terms used

The terms used in these regulations should be interpreted as meaning the same as in the Higher Education and Scientific Research Act, insofar as they are defined in that Act.

The following terms are to be defined thus:

- a. the Act: the Higher Education and Scientific Research Act (in Dutch, the WHW), in the Dutch Bulletin of Acts, Orders and Decrees, number 593 and as amended since;
- b. the Dean: If an institution that is fully or partly responsible for the programme has opted for a Joint Department Board, then "Dean" will also include the Department Board; where matters relate only to one of the departments named on the title page: the Dean of that department: for broader issues: the three Deans collectively;
- c. programme: the Master's degree programme as denoted in Article 7.3a paragraph 1, subparagraph b of the Act;
- d. student: anyone enrolled at Eindhoven University of Technology, Delft University of Technology or the University of Twente as a student or external student for the purpose of benefiting from education or for the purpose of sitting the interim examinations and undergoing the examination which form part of the programme;
- e. subject: a unit of study within the programme as referred to in Article 7.3, paragraphs 2 and 3 of the Act;
- f. practical: a practical exercise as intended in Article 7.13, paragraph 2, subparagraph d of the Act, taking one of the following forms:
 - writing a thesis
 - conducting a project or developing an experimental design
 - completing a design or research assignment
 - conducting a literature review
 - completing an internship
 - giving a public presentation
 - participating in fieldwork or an excursion
 - conducting tests and experiments

- writing a position paper
 - or participating in other educational activities aimed at enabling participants to attain certain knowledge, insights or skills;
- g. interim examination: an assessment of the student's knowledge, insight and skills in relation to a subject, as well as the marking of that assessment by at least one examiner, appointed for that purpose by the Board of Examiners;
- h. examination: an assessment by which the Board of Examiners, in accordance with Article 7.10 of the Act, establishes whether all examinations in the various subjects that constitute the Master's degree programme have been successfully completed;
- i. Board of Examiners: the programme's Board of Examiners, which has been installed in accordance with Article 7.12 of the Act;
- j. examiner: the individual who, in line with Article 7.12, paragraph 3 of the Act, has been appointed to set the examinations;
- k. credit: a credit awarded in accordance with the European Credit Transfer System (ECTS); one credit denotes a study load of 28 hours;
- l. working day: Monday to Friday with the exception of recognised national public holidays;
- m. study guide: a guide to the degree programme containing specific information pertaining to the various subjects;
- n. institution: Eindhoven University of Technology, Delft University of Technology or the University of Twente;
- o. disability: all conditions which are (at least for the period in question) chronic or lasting in nature and which form a structural limitation for the student in receiving education, sitting interim examinations or taking part in practicals.

Article 2 – Programme composition

1. The following points regarding the programme are included in the Implementation Regulations in the appendix:
 1. study load,
 2. composition of the degree programme.
 3. core programme,
 4. elective subjects,
 5. homologation courses,
 6. internship,
 7. graduation work,
 8. study programme,
 9. elective degree programme,
 10. the form of the interim examinations,
 11. The frequency, terms and sequence of interim examinations.
2. The appendix forms an integral part of these regulations.

Article 3 – The programme's final attainment levels

Embedded Systems graduates:

- 1. Have a holistic view on embedded systems, their development, and their embedding in larger systems
- 2. Are able to master complex embedded systems
- 3. Can describe and study structure and behaviour of embedded systems
- 4. Possess knowledge of contemporary techniques
- 5. Are proficient in the Design of embedded systems
- 6. possess knowledge of requirement engineering, modelling, testing and implementation techniques
- 7. Have a flexible and inquisitive mind with regard to developments in the field

- 8. Invent own specific tools, theories and techniques if unavailable
- 9. Are aware of their own position and that of embedded systems in society
- 10. Can present and communicate their ideas and visions on embedded systems
- 11. Can work in a multidisciplinary design team

Article 4 – Admission to the programme

1. Students in possession of a Bachelor degree in Electrical Engineering (*Elektrotechniek*) or Computer Science (*Technische Informatica, Telematica* or *Informatica*) from a Dutch university are eligible for direct admission to the programme.
2. Students in possession of another Bachelor's degree issued by a Dutch university are eligible for admission to the programme if their knowledge and skills are comparable to as under 1) after following a pre-master programme.
3. Students in possession of a Dutch Bachelor's degree issued by a School of professional education (Dutch: HBO, HTS) can gain admission after first successfully completing a bridging programme; to be admitted to the bridging programme, tests of English and mathematics have to be passed.
4. Students who are not in possession of the diploma mentioned in paragraph 1, 2 or 3 will require a certificate of admission issued by the Dean.
5. Notwithstanding the provisions of paragraph 1, 2 and 3, the Dean may under special circumstances admit a student to one or more interim examinations or practicals of the programme before the student has passed the Bachelor's examination. A limited period of validity may be set for such permission.
6. A student that is in the possession of a non-Dutch Bachelor degree is eligible for admission to the programme if:
 - 1) The field and the level of the Bachelor degree are comparable to those of the Dutch Bachelor degrees that give admittance to the Master's programme.
 - 2) As a guide-line for admission: student must have a Grade Point Average (GPA) of at least 75% of the maximum available points.
 - 3) Student provides one of the following proofs of English language proficiency:
 - An IELTS (academic version) overall Band score of at least 6.5,
 - a TOEFL (Test of English as a Foreign Language) score of at least 90 (internet-based test),
 - or a proof that he/she has passed the University of Cambridge 'Certificate of Proficiency in English' or the University of Cambridge 'Certificate in Advanced English'

Nationals from the USA, U.K., Ireland, Australia, New Zealand and Canada are exempt from the proof of English language proficiency requirement.
7. For admission to the EIT-ES track the student should satisfy the admission rules of the ES program, specified in Article 4. In addition, an admission committee appointed the EIT-ICT Labs technical major will review the applications both for technical and entrepreneurial and innovative qualities.

Article 5 – Language

Education shall be provided in English. Students shall sit interim examinations and undergo the examination in English. The Dean has the authority to adapt language criteria under certain circumstances.

Section 2 – Interim examinations

Article 6 - Number, times and frequency of examinations

1. There are at least two opportunities in each academic year to sit interim examinations.
 - the first opportunity is immediately after the teaching period for the course to which the interim exam in question relates,
 - the second opportunity is at the end of the subsequent teaching period during the same academic year, or else during the resit period in August.
2. A time table of all opportunities for sitting written interim examinations is drawn up before the start of each semester and details are published. If absolutely necessary, changes can be made to this interim examinations time table but only with approval of the Board of Examiners and if the changes are communicated to students through the official means of communication at least 4 weeks in advance. In case of force majeure, deviation from this period is allowed, only by decision of the Board of Examiners.
3. Notwithstanding the provisions of paragraph 1, there will be at least one opportunity in a year to sit interim examinations relating to subjects not taught in that academic year.
4. If a subject is removed from the study programme, there will be two resits in the following academic year.
5. In exceptional cases, the Board of Examiners may permit a deviation from the standard number of times and the way in which certain interim examinations may be administered in favour of the student.

Article 7 – Validity of interim examinations

1. The result of an interim examination is valid for an unlimited period.
2. However, in cases where the interim examination result dates from over six years ago, the Board of Examiners may impose an additional or substitute interim examination.

Article 8 - The form of the interim examinations

1. Interim examinations will be administered in accordance with the details set out in the prospectus of the subject in question.
2. Interim examinations held within the framework of another programme are administered in accordance with the procedure set out in, or pursuant to, the Teaching and Examination Regulations of that other program.

Article 9 – Oral interim examinations

1. Oral interim examinations will be held in public, unless determined otherwise by the Board of Examiners in a special case or unless the student has formally objected to the public nature of the interim examination.
2. As a rule a second examiner will be present at an oral interim examination, but not at the University of Twente.
3. Prior to an oral interim examination, the examiner must ask the student to provide proof of identity.

Article 10 – Determining and announcing the results

1. The examiner is required to determine the result of an oral interim examination as soon as the interim examination is finished and to supply the student with a written statement of the result.

2. In the case of written interim examinations, the examiner is required to determine the result as soon as possible after the interim examination but within 15 working days at most. Taking due account of the student's right to privacy, the student administration then ensures that the results are registered and published within 20 working days of the interim examination date. If the examiner is unable to meet these criteria due to extenuating circumstances, the examiner must inform the Board of Examiners, stating reasons for the delay. The Board of Examiners will then pass this information on to the student or students without delay, and a new date for announcing exam results will simultaneously be made known.
3. Interim examinations taken in other than oral or written form are usually taken by delivering a report or an elaboration of exercises, here referred to as a deliverable. In case several pieces of work need to be delivered, the last piece of work is meant. The examiner will determine the result of such an interim examination as soon as possible, but within 15 working days after the final delivery date that has been determined by the examiner and has been communicated to the student, provided that the piece of work has been delivered by the student before the set deadline.
4. When receiving the result of an interim examination, the student will be made aware of his or her right to inspect the results as referred to in Article 10, the opportunity for a subsequent discussion as referred to in Article 11 and the opportunity to lodge an appeal with the Examination Appeals Board.

Article 11 – The right to inspect the results

1. For a period of at least 20 working days after notification of the results of any written interim examination, the student has the right to inspect his or her marked work, on request. If requested, he or she will be supplied with a copy of the marked work.
2. During the period referred to in paragraph 1, all interested individuals may acquaint themselves with the questions and assignments set in the interim examination in question, as well as with the criteria used for marking.
3. The Board of Examiners may determine that the right to inspection as referred to in paragraphs 1 and 2 will be exercised at a location specified beforehand and at no less than two specific times, also to be decided in advance.

If the student can prove that he/she is or was unable to be present at the location at the set time due to circumstances beyond his or her control, then another opportunity will be provided, if possible within the period stated in paragraph 1.

The location and times mentioned in the first sentence will be announced within five working days.

Article 12 – Subsequent discussion of the interim examination results

1. As soon as possible after the results of an oral interim examination have been announced, an opportunity will be arranged for the examiner to discuss the results with the student, if so requested by the student or at the instigation of the examiner. At this meeting, the rationale behind the marks awarded will be explained.
2. For a period of 20 working days after the results have been announced, students who have taken a written interim examination may submit a request to discuss the results with the relevant examiner. The discussion will take place within a reasonable time span and at a place and time determined by the examiner.
3. In cases where a collective discussion is organised by or on the instructions of the Board of Examiners, a student may only submit a request, as referred to in the preceding paragraph, if the student was present at the collective discussion and if the student provides a good reason for the request or if, due to circumstances beyond the student's control, the student was unable to attend the collective discussion.
4. The provisions of paragraph 3 are similarly applicable if either the Board of Examiners or the examiner first gives the student the opportunity to compare his/her answers with model answers.
5. The Board of Examiners may permit deviations from the provisions of paragraphs 2 and 3.

Section 3 – Studying with a disability

Article 13 – Adaptations to assist students with a disability

1. Students who have a physical or sensory disability are entitled to adaptations in teaching, interim examinations and practicals. If possible, the student must submit a written request to the Dean at least three months before the student is due to participate in coursework, interim examinations or practicals. These adaptations will be geared as much as possible to a student's individual needs, but they must not affect the quality or the degree of difficulty of a subject or an interim examination programme. The facilities provided to this end may involve adapting the form or duration of interim examinations or practicals to the student's individual situation or making practical aids available. At Eindhoven University of Technology, this request should be submitted to the STU/International Relations Office. At Delft University of Technology and at the University of Twente, this request should be submitted to either a university student counsellor or the department student counsellor.
2. The request referred to in paragraph 1 should be accompanied by a recent medical certificate from a doctor or a psychologist. If there is evidence of dyslexia, for example, the request should be accompanied by a document issued by a recognised dyslexia-testing bureau (i.e. registered with BIG, NIP, or NVO). If possible, this certificate should also give an estimation of the extent of the disability.
3. The Dean will decide on requests for adaptations to the educational environment. The Board of Examiners will decide on requests for adapting interim examinations. The decision must be announced within four weeks.

Section 4 – Approval by the Board of Examiners

Article 14 Exemption from interim examinations or practicals

1. After having been advised by the relevant examiner, the Board of Examiners may decide to exempt students from an interim examination or practical. Conditions for exemption are to be specified in the Rules and Regulations of the Board of Examiners.
2. The Board of Examiners may exempt a student from a specific interim examination only on the grounds of the content, level and quality of interim examinations successfully completed earlier or on the grounds of the student's prior knowledge, insights and skills developed outside of higher education.

Article 15 Elective subjects

Criteria for approval of elective subjects to be followed by the student, are contained in the Implementation Procedures (appendix A).

Article 16 Flexible study programme

1. Students can compile their own degree program, with an associated degree audit. The degree program, which requires prior approval by the Board of Examiners, must consist wholly or largely of components taught at one of the three universities within the framework of, or in support of, the program. It may be supplemented by components taught within the framework of, or in support of, other degree programs.
2. When applying to the Board of Examiners for the prior approval referred to in paragraph 1, students must provide details of their reasons for making this request.

Section 5 – Examination

Article 17 – The times and frequency of the examination

There shall be an opportunity to undergo the Master’s final examination at least twice a year. The dates set by the Board of Examiners are to be published before the start of the academic year.

Article 18 – Student support and guidance

Responsibility for student support and guidance lies with the Dean. This includes informing students about study options within the programme or elsewhere. One or more study advisers may be appointed for this purpose.

Article 19 – Monitoring academic progress

1. The Dean is responsible for the registration and timely publication of the exam results of individual students in the institution’s virtual learning system.
2. The Dean is responsible for facilitating discussion of the results between the student and the study adviser, when appropriate.

Section 6 – Appeals and objections

Article 20

1. Decisions by the Board of Examiners based on these regulations may be appealed within four weeks after the announcement of the decision to the student in question. Appeals should be lodged with the Examination Appeals Board.
2. Decisions by the Dean based on these regulations may be appealed within six weeks after the announcement of the decision to the student in question. Objections are to be lodged with the Dean.

Section 7 – Contravention, changes and implementation

Article 21 – Contravening the Regulations

If the study guide or any other regulations relating to the study programme or the interim examination programme prove to contravene these Regulations and the accompanying appendix, precedence will be given to the provisions of these Regulations with which the appendix forms an integral whole.

Article 22 – Amendments to the regulations

1. Any amendments to these regulations will be made by special resolution of the Dean.
2. No amendments will affect the current academic year unless it is reasonable to suppose that the interests of students will not be adversely affected.
3. Amendments to these regulations may not retroactively affect a decision by the Board of Examiners to the detriment of the student.

Article 23 – Transitional regulations

1. If the composition of the study programme undergoes intrinsic changes or if these regulations are amended, the Dean will draw up transitional regulations that will be incorporated into appendix of these Regulations.
2. If and when appropriate, such transitional regulations are required to include:
 - a. a provision concerning the exemptions that can be given on the basis of the interim examinations already passed;
 - b. a provision specifying the validity of the transitional regulations.

Article 23 – Publication of the regulations

The Teaching and Examination Regulations and the appendix, which forms an integral whole with the Regulations, shall be published on the institution's website.

Article 25 – Entry into force Date of Commencement

These regulations will come into effect on September 1, 2013.

Approved by the Executive Board of Delft University of Technology on dd.mm.yyyy, by the Executive Board of Eindhoven University of Technology on dd.mm.yyyy and by the Executive Board of the University of Twente on dd.mm.yyyy.

APPENDIX A

IMPLEMENTATION REGULATIONS

2013-2014

**3TU MASTER'S DEGREE PROGRAM
EMBEDDED SYSTEMS**

**EINDHOVEN UNIVERSITY OF TECHNOLOGY
DELFT UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF TWENTE**

Article 1 - Study load

1. The Master's degree audit for the Embedded Systems programme has a study load of 120 credits.
2. The programme can be followed in full-time.
3. The programme has a duration of two years and starts each year in September. At Eindhoven University of Technology and at Delft University of Technology, it is also possible to start the Master's degree programme in the second semester. In that case, however, students might experience some problems due to dependencies between some of the course taught in the first semester and some of the courses in the second semester. Nevertheless, the courses in the master programme will be scheduled in such a way that it is possible to compose an individual study programme consisting of a limited choice of courses, in which the successor relationships are hardly violated. Students should realize, however, that starting in the second semester could take some extra effort.
4. A special track within this programme is dedicated to the European Institute of innovation and Technology – Embedded Systems (EIT-ES) special master's program. This special track is described in Appendix A.

Article 2 - Composition of the degree program

The composition of the study programme is as follows:

- a. Core programme worth 25 credits described in Article 3,
- b. Specialisation subjects worth at least 15 credits, as described in Article 4,
- c. Homologation courses worth at most 20 credits described in Article 5,
- d. An optional internship worth at most 20 credits or a multi-disciplinary design project worth 10 credits, but not both, described in Article 6, and
- e. A graduation work (40 EC), further described in Article 7, comprising preparation for the graduation project worth 10 credits, and th graduation project worth 30 credits.

Article 3 – Core program

The core programme consists of the following courses:

TUD Code	TU/e Code	UT Code	Subject	Credits
IN4340	5KK73	192130240	Embedded Computer Architecture	5
IN4390	2IN27	201200006	Quantitative Evaluation of Embedded Systems	5
IN4342	5KK03	201000168	Embedded Systems Laboratory	5
IN4343	2IN26	192130200	Real-time Systems	5
IN4387	2IW26	192140122	System Validation	5

If the content of a compulsory course corresponds to the course contents of a preliminary education course, the compulsory course has to be replaced by a course, with the same amount of credit points, from the specialisation part.

Article 4 – Specialisation subjects

Specialisation subjects totalling at least 15 credits should be selected from the following lists from the three universities in question.

Subjects offered by the Eindhoven University of Technology:

Code	Subject	Credits
Compulsory Courses		
2II45	Architecture of distributed systems	5
2IW15	Automated reasoning	5

5KK60	Systems on silicon	5
5KK80	Multiprocessors	5
2IM92/5T514	Preparation graduation project ES	10
Elective courses		
2IN28	Grids and Clouds	5
2II65	Metamodeling and interoperability	5
5DD50	Advanced topics in multimedia coding	4
5L130	Electrophysiology	3
5ME00	Signal processing for communication	3
5ME10	Statistical signal processing	3
5ME20	Ubiquitous computing and activity recognition	5
5MX00	Dynamical systems	3
5N280	Low-power Electronics	4
5P340	Information theory 2	4
5P450	Analogue/digital and digital/analogue converters	4
5P530	Video processing for multimedia systems	4
5P690	Advanced actuator systems	4
5SC21	Modeling and predictive control	3
2ID26	Web Information retrieval and data mining	5
2ID56	Adaptive web-based systems	5
2II36	Web-based interactive systems	5
2II70	Constraint programming	5
2IL45	Advanced algorithms	5
2IS15	Generic language technology	5
2IS25	Distributed trust management	5
2IV05	Additional component computer graphics	5
2IV35	Visualization	5
2IW55	Algorithms for model checking	5
9ST14	Academic skills in English 1 ¹	4
5P050	Selected topics in Electronics	4
2IW01	Embedded computer architecture 2 ²	5
5MB30	Robust control	3
5MC10	Combinatorial algorithms	3
5MD00	Computer architecture	3
5MG00	Mathematics for electromagnetism	3
5MH00	Computational electromagnetics	3
5MY10	Wireless communication I	3
5P500	Monitoring of respiration and circulation	3
5SC20	State space control	3
5KK06	Computer arithmetic ³	5
2IW04	Knowledge based control systems ⁴	5
5DD40	Multimedia video coding and architecture	4
5MB10	Model reduction	3
5MB20	Adaptive information processing	3
5MB40	System identification	3
5MD20	Design automation	3

¹ For foreign students, and for students who have completed a polytechnic (*HBO*) computer science programmeof.

² Televised lectures offered by the University of Twente.

³ Televised lectures offered by Delft University of Technology.

⁴ Televised lectures offered by Delft University of Technology.

5MF00	EM waves and antennas	3
5MH20	EM theory of wave guides	3
5MH30	Optical communication technology	3
5P060	Nonlinear systems / neural networks	4
5P670	Advanced topics in multi-service data networks I	2
5TT40	RF transceiver Electronics	3
2IC35	Physical aspects of computer security	5
2ID35	Database technology	5
2IF02	Verification of security protocols	6
2IF45	Process algebra	5
2IF65	Proving with computer assistance	5
2II55	Business process management systems	5
2II75	Business process simulation	5
2IL55	Geometric algorithms	5
2IN35	VLSI programming	5
2IP45	Software project management	5
2IS55	Software evolution	5
2IV15	Simulation in computer graphics	5
2IV55	Interactive virtual environments	5
5P220	Antennas and propagation	4
5P480	Knowledge systems and applications	4
5P630	Special topics in power electronics	4
5TT30	Photonic IC design	3
5TT50	Advanced CMOS design	4
2IW02	Real-time software development ⁵	5
5N520	Statistical bioinformatics	2
5P680	Advanced topics in multi-service data networks II	2
5TT00	Optical communication networks	3
5KK04	Networked embedded systems	5
Seminar (second year)		
2ID95	Seminar databases and hypermedia	5
2IF96	Seminar formal system analysis	5
2II96	Seminar architecture of information systems	5
2IL95	Seminar algorithms	5
2IN95	Seminar systems architecture and networking	5
2IS95	Seminar software engineering and technology	5
2IV95	Seminar visualization	5
2IF02	Seminar information security technology	6
Capita Selecta (second year)		
2IS99	Capita selecta software engineering and technology	5
2IC99	Capita selecta security	5
2ID99	Capita selecta databases and hypermedia	5
2IF98	Capita selecta formal system analysis	5
2II99	Capita selecta architecture of information systems	5
2IL99	Capita selecta algorithms	5
2IN99	Capita selecta systems architecture and networking	5
2IV99	Capita selecta visualization	5
Internship / Multi-disciplinary design project (second year)		
2IM02/5L990	Internship	15

⁵ Televised lectures offered by the University of Twente.

2IW70/5KK05	Multi-disciplinary design project	10
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Subjects offered by the Delft University of Technology:

Code	Subject	Credits
ET4036	Transmission Systems Engineering	4
ET4054	Methods and Algorithms for System Design	5
ET4076-11	VLSI Test Technology & Reliability	4
ET4078	Computer Architecture (Special Topics)	4
ET4147	Signal Processing for Telecommunication	4
ET4164	Information Theory	4
ET4170	Computer Arithmetic	5
ET4171	Processor Design Project	5
ET4235	Digital Signal Processing	4
ET4257	Sensors and Actuators	4
ET4258	Displays and Imaging sensors	4
ET4260	Microsystem Integration	4
ET4269	Multimedia Compression	6
ET4277	Reliability Engineering	4
ET4283	Advanced Digital Image Processing	6
ET4284	Ad-hoc Networks	4
ET4285	Measuring and Simulating the Internet	4
ET4287	Advanced Mobile and Wireless Networking	4
ET4293	Digital IC Design	4
ET4351	VLSI Systems on Chip	4
ET4359	Advances in Networking	5
ET4370	Reconfigurable Computing Design	5
ET4381	Advanced Multicore Systems	5
IN4357	Algorithms for Model Checking	5
IN4012	Real-time Artificial Intelligence and Automated Speech Recognition	6
IN4015	Neural Networks	6
IN4026	Parallel Algorithms and Parallel Computers	6
IN4027	Seminar Algorithms	5
IN4049	Introduction to High Performance Computing	6
IN4073	Embedded Real-Time Systems	6
IN4397	Combinatorial Solvers	6
IN4085	Pattern Recognition	6
IN4091	Systems Specification Models	5
IN4150	Distributed Algorithms	6
IN4182	Digital Audio and Speech Processing	6
IN4191	Security and Cryptography	5
IN4303	Compiler Construction	5
IN4314	Seminar Selected Topics in Multimedia Computing	5

IN4315	Seminar Software Exploration	6
IN4398	Seminar Internet of Things	5
IN4341	Performance Analysis	
IN4350	Embedded Computer Architectures 2 ⁶	5
IN4351	Real-Time Software Development ⁷	5
IN4354	Seminar Human-Agent/Robot Teamwork	5
IN4388	Empirical Evaluation of Algorithms	5
SC4025	Control Theory	6
SC4040	Filtering and Identification	6
SC4050	Integration Project SC	5
SC4060	Model Predictive Control	4
SC4070	Control Systems Lab	4
SC4081-10	Knowledge Based Control Systems	4
SC4091	Optimization in Systems and Control	4
SC4092	Modeling and Nonlinear Systems Theory	4
SC4160	Modelling and Control of Hybrid Systems	3
WB2414-09	Mechatronic System Design	4
WM0201TU-Eng	Technical Writing	2
WM0203TU-Eng	Oral Presentation	2
WM0781TU	Patent Law and Patent Policy	3
WM1101TU	English for Academic Purposes-3	3
WM1102TU	Written English for Technologists-2	3
WM1112TU	Spoken English for Technologists-2	2
WM1115TU	Elementary Course Dutch for Foreigners	3
WM1116TU	Elementary Course: Dutch for Foreigners, Follow Up	3
WM1135TU	English for Academic Purposes-4	3

Subjects offered by the University of Twente:

Code	Subject	Credits
191210790	Transmission media	5
191210870	Integrated circuits and systems for mixed signals	5
191210900	Introduction to Biometrics	5
191211080	Systems Engineering	5
191211590	System on Chip for ES	5
192110940	Secure Data Management	5
192111332	Design of software architectures	5
192111700	Computability and computational complexity	5
192130022	Design of digital systems	5
192130092	Fault tolerant digital systems	5
192135310	Modeling and analysis of concurrent systems 1	5
192620000	Telematics networks	5
192654000	Network Security	5
201000075	Wireless Sensor Networks	5

⁶ Televised lectures offered by the University of Twente.

⁷ Televised lectures offered by Delft University of Technology.

191210760	Advanced programming	5
191210770	Digital control engineering	5
191210790	Transmission Media	5
191211100	Mechatronic design of motion systems	5
191211110	Modelling and Simulation	5
192135400	Advanced design of software architectures – Product Line Engineering	5
191210960	Signal processing in acoustics and audio	5
192130112	Distributed systems	5
192130122	Energy Efficient Embedded Systems	5
192130250	Embedded computer architectures 2	5
192135320	Modeling and analysis of concurrent systems 2	5
192620010	Mobile and wireless networking 1	5
201200122	Algorithms for model checking ⁸	5
201000231	Computer arithmetic ⁹	5
201000232	Knowledge based control systems ¹⁰	4
191210341	Physical modeling of Embedded Systems	5
191210850	Advanced analog IC electronics	5
191210950	Implementation of Digital Signal Processing	5
191561620	Optimal control	5
192111301	Ubiquitous computing	5
192130200	Real-time systems 1	5
192135450	Advanced design of software architectures-Model Driven Engineering	5
192170015	Testing techniques	5
191210910	Image processing and computer vision	5
191210920	Optimal estimation in dynamic systems	5
191211060	Modern robotics	5
191211320	Testable design and test of integrated systems	5
192110280	Advanced programming concepts	5
192110280	Mobile and wireless networking 2	5
191210840	A/D Converters	5
191210940	Advanced digital signal processing	5
191211030	Mobile Radio communication	5
191211060	Modern Robotics	5
191211090	Real-time software development	5
191211330	Digital electronic circuit design for SoC	5
191520252	Theory of complex functions	5
191560561	Introduction to mathematical system theory	5
192130210	Real-time systems 2	5
201100254	Advanced computer vision & pattern recognition	5

⁹ Telelecture offered by Delft University of Technology

¹⁰ Telelecture offered by Delft University of Technology

Article 5 - Homologation courses

- Students who have completed a Dutch university Bachelor's degree programme in computer science are required to include the following subjects in the homologation part of the master program:

At Eindhoven University of Technology:

Code	Subject	Credits
5HH00	Electronics for embedded systems	3
5DD17	Circuit analysis	3
5HH30	Digital signal processing	3

At Delft University of Technology:

Code	Subject	Credits
For a student with a bachelor's degree in Computer Science of DUT:		
TI2715-A ¹¹	Signaalverwerking	5
TI2725-B ¹²	Digitale Systemen	5
TI2735-C	Embedded Software	5
SC2531EE	Dynamic Systems	3
SC3542EE	Control Systems	3

At the University of Twente:

Code	Subject	Credits
191210001	Instrumentation of Embedded Systems	5
191561800, 201100109	Signalen en Systemen, or Signals and Transformations	5
and one of the courses		
191210341	Physical modeling of Embedded Systems	5
191210441	Control Theory	5
191210590	Embedded Signal Processing	6

- Students who have completed a Dutch university Bachelor's degree programme in electrical engineering are required to include the following subjects in the homologation part of the master program:

At Eindhoven University of Technology:

Quartile	Code	Study component	Credits
1	2IL65	Algorithms	3
2	5HH00	Electronics for embedded systems	3
3	2IW80	Software specification and testing	5

At Delft University of Technology:

Quartile	Subject	Credits
TI1705	Softwarekwaliteit en Testen	5
TI2725-A	Operating Systems	5
TI2720-C	Embedded Software	4
TI2200	Software Engineering Methods	4

At the University of Twente:

Code	Subject	Credits
192110452	Operating systems	5
191210760	Advanced programming	5
and one of the courses		

¹¹ Alternative course: IN4309 Random Signal Processing, 5 EC

¹² Alternative course: EE1410 Digitale Systemen, 5 EC

192112051	Functional Programming	5
192135100	Software Engineering Models	5
192135201	Formal methods for software engineering	5
191211090	Real time software Development	5

3. Students who have completed a polytechnic programme of computer science or electrical engineering taking the bridging courses for polytechnic graduates are required to include some subjects as homologation subjects in the Master's degree program. This is determined by the Board of Examiners at Delft University of Technology and University of Twente. At Eindhoven University of Technology, there is the following fixed package of courses:

Quartile	Code	Subject	Credits
1	2IL65	Algorithms	3
2	5HH00	Electronics for embedded systems	3
3	2IW80	Software specification and testing	5
4	5JJ50	Computational networks	3

Those taking the bridging courses for polytechnic graduates may be given permission to take part in some of the units of the Master's degree program. A necessary condition for permission is that the student has at least scored 15 credit points from the programme of bridging courses.

4. For admitted students not mentioned in paragraph 1 and 2 an individual homologation programme is made by the Board of Examiners.

Article 6 – Internship and Multi-Disciplinary Design Project

- At the University of Twente, students can complete an internship worth 20 credits. At Delft University of Technology, students can complete an internship worth 12 to 20 credits. At Eindhoven University students can complete an internship worth 15 credits, or a multi-disciplinary design project worth 10 credits, but not both, only after an agreement with the student advisor.
- Students may not commence an internship or multi-disciplinary design project until they have:
 - completed courses from their individual study programme amounting to at least 45 credits,
 - completed all bridging courses (in the event that such a course was required in accordance with Article 9, paragraph 1).

Article 7 – Graduation Work

- The graduation work of 40 credits consists of a preparation for graduation project worth 10 credits and a graduation project of 30 credits:

Location	Preparation	Graduation Project
Delft	IN4610 Research Project	IN4600 Final Project
Eindhoven	2IM92 Preparation Graduation	2IM91/5T746 Master project
Twente	191211749 Individual project	192199978 Final project

- Preparation for graduation project consists of literature survey, feasibility study and detailed planning for the graduation project. The preparation has to be finished and marked before the start of the graduation project.
- Graduation project consists of performing the project, writing a graduation report and its summary, and preparing and giving a presentation.

4. Students may not commence the graduation project until they have:
 - successfully completed at least 68 credit units of their study program, and
 - successfully completed all homologation and bridging courses (in the event that such courses were required in accordance with Article 9, paragraph 1).

Article 8 – Study Program

1. Students must draw up their study programme and submit this, together with the name of their supervisor to the Board of Examiners for approval before the start of the 4th quarter of their first year.
2. The composition of the thesis committee has to be submitted to the Board of Examiners within a month of starting their final thesis project.
3. Each individual amendment to an approved study programme or an approved thesis committee must be resubmitted to the Board of Examiners for approval.

Article 9 – Bridging Courses

1. In addition to the programme referred to in Article 2, students will only be admitted to the programme on the basis of a relevant Bachelor's degree awarded by a Dutch institute of professional education (*HBO: Elektrotechniek, Embedded Systems or Technische Informatica*) if they first complete a programme of bridging courses (preferably within a year of commencing their course of study) that includes the following subjects:

At Eindhoven University of Technology:

For Dutch students:

Code	Program unit	Credits
2DL03	Basic mathematics	3
2DL04	Calculus A	3
2DL06	Linear algebra	3
2DL07	Statistics A	3
2IT60	Logic and set theory	5
2IT70	Automata and process theory	5
5DD17	Circuit analysis	3
5HH30	Digital signal processing	3

For foreign students:

Code	Program unit	Credits
2DE20	Mathematics 1	5
2DL07	Statistics A	3
2IT60	Logic and set theory	5
2IT70	Automata and process theory	5
2WAB0	Calculus variant A	5
5DD17	Circuit analysis	3
5HH30	Digital signal processing	3

At Delft University of Technology:

Code	Subject	Credits
<i>TI1305</i>	<i>Redeneren en Logica</i>	<i>5</i>
<i>TI2715-A</i>	<i>Signaalverwerking</i>	<i>5</i>
TI2725-A	Operating Systems	5

TI2725-C	Embedded Software	5
<i>WI1708TH1</i>	<i>Analyse deel 1</i>	<i>3</i>
<i>WI1708TH2</i>	<i>Analyse deel 2</i>	<i>3</i>
<i>WI1807TH1</i>	<i>Lineaire Algebra 1</i>	<i>3</i>
<i>WI1807TH2</i>	<i>Lineaire Algebra 2</i>	<i>3</i>
For students with an `HBO degree' <i>Technische Informatica</i>		
TI2725-B or EE1400	Digitale Systemen	5
SC2531EE	Dynamische systemen	3
SC3542EE	Regeltechniek	3
For students with an `HBO degree' <i>Elektrotechniek</i> :		
EE1400	Programmeren in C	3
TI1705	Softwarekwaliteit en Testen	5
TI2205	Software Engineering Methods	5

The bridging programme is completed when the courses printed in italics and at least 8 EC of the other courses have been completed. The remaining courses will be included in the master's programme as homologation courses.

The TU Delft bridging programs are valid for two years. If a programme has not been completed within two years, students have to transfer to the new bridging program, with the understanding that credits earned for courses that are identical in the old and the new bridging programme remain valid.

At the University of Twente:

Quartile	Code	Subject	Credits
1	191512001	<i>Calculus A</i>	4
1	191512021	<i>Calculus B</i>	3
1	191512061	<i>Lineaire Algebra A</i>	3
2	191231490	<i>Lineaire Systemen</i>	6
2	191512041	<i>Calculus C</i>	3
2	191512081	<i>Lineaire Algebra B</i>	2
For students with an `HBO degree' <i>Elektrotechniek</i> :			
1	192191500	Self tuition project (programming)	5
For students with an `HBO degree' <i>Technische Informatica, Computertechniek</i>			
2	191210001	<i>Instrumentation for Embedded Systems</i>	5

Appendix B – EIT – ES Special Track

A-1 Composition of the Special Track

The programme comprises 120 credit units, divided into the following components:

1. Common Base: a set of courses worth 30-32 credit units (for TU Eindhoven: 31 credit units), described in Article A-2,
2. Specialisation: a set of courses worth 25-40 credit units (for TU Eindhoven: 33 credit units), described in Article A-3,
3. Innovation and Entrepreneurship: a set of courses, workshops (summer and winter schools) and projects, worth 30 credit units (for TU Eindhoven: 24 credit units, plus 6 credit units as part of graduation work), described in Article A-4, and
4. Graduation work, worth 30-40 credit units (for TU Eindhoven 36 credit units, comprising 30 credit units for the graduation project and 6 credit units for the innovation and entrepreneurship minor thesis), described in Article A-5.

The student starts the study at two universities in two different institutions and in two different countries: the first year is spent at the entry node taking the common base courses and part of your innovation and entrepreneurship module and then the student moves to the exit node for the specialization courses and the graduation project as well as the rest of the innovation and entrepreneurship modules.

The EIT Embedded Systems programme requires mobility among six renowned European universities, listed below:

- **Aalto University** (Aalto), Finland,
- **Royal Institute of Technology** (KTH), Sweden,
- **Technische Universität Berlin** (TU Berlin), Germany,
- **3TU.Federation** (3TU), represented by TU Eindhoven, The Netherlands,
- **Turku Centre for Computer Science** (TUCCS), Finland, and
- **University of Trento** (UNITN), Italy.

After finishing the first year at the entry nodes (KTH for EE students, TU Berlin for CE students and TU Eindhoven for CS students), the student moves for the second year studies to the exit node. During the second year, the student will have the option of specializing in one of the following areas offered at the following exit nodes:

- UNITN: Real-Time Embedded Systems
- TU Eindhoven: Embedded Networking
- KTH: Embedded Platforms
- TUCS: Energy Efficient Computing
- Aalto: Mobile Cyber-Physical Systems
- TU Berlin: Embedded Multicore Processing

A-2 Common base courses

Below we indicate how the common base is implemented at the 3 entry points:

KTH		TU Berlin		TU Eindhoven	
Course Title	ECTS	Course Titles	ECTS	Course Titles	ECTS

Embedded Systems	7,5	Advanced Computing Architecture	6	Embedded Systems Laboratory (5KK03)	5
Research Methodology and Scientific Writing	7,5	Embedded Operating Systems	6	Embedded Computing Architecture (5KK73)	5
Compiler and execution environments	7,5	Quality Assurance for Embedded Systems	6	Real--Time Systems (2IN26)	5
Computer Systems Architecture	7,5	Compiler Construction I	6	System Validation (2IW26)	5
Embedded Software	7,5	Project of Embedded System Design	6	Quantitative Evaluation of Embedded Systems (4C390)	5
-	-			Circuit Analysis (5DD17)	3
				Electronics for Embedded Systems (5HH00)	3
	37,5		30		31

All courses are taught in English and have an established record of being offered for several years in their respective institutes.

A-3 Specialisation

At TU Eindhoven, the students are supposed to follow a number of mandatory specialisation courses listed below, worth 20 credit units. Moreover, they have to choose a number of elective courses, listed below, for the total of 13 credit units.

Specialization Embedded Networking (TU Eindhoven)

Mandatory Courses	Code	ECTS	Elective Courses	Code	ECTS
Architecture of Distributed Systems	2II45	5	Wireless Communication I	5MY10	3
Wireless Sensor Networks		5	Physical Aspects of Computer Security	2IC35	5
Grids and Clouds	2IN28	5	Advances in Networking		5
Ubiquitous Computing and Activity Recognition	5ME20	5	Seminar System Architecture and Networks	2IN95	5
			Measuring and Simulating the Internet	ET4285	4
			Energy Efficient Embedded Systems	192130122	5

The specialisation courses at the other exit nodes are given below.

Real-Time Embedded Systems (UNITN):

Mandatory Courses	ECTS	Elective Courses	ECTS
Laboratory of Embedded Control Systems	6	Lab. of Nomadic Communication	6
Safety critical systems	6	Network Security	6
<i>One of the two following</i>		Wireless Sensor Networks	6
Lab. of Wireless Sensor Networks	6	Hardware Software Codesign	6
Hardware Software Co-Design	6	computing systems for signal processing	6
		Optimization of Electronic Systems	6
		Signals and Systems	6

Embedded Platforms (KTH)

Mandatory Courses	ECTS	Elective Courses	ECTS
Digital Design with HDL	7.5	System Design Languages	7.5
Design Project	7.5	Signal Theory	7.5
		Radio Electronics	7.5
		Digital Communication	7.5
		System Level Design Methodology	7.5
		Embedded Hardware	7.5

Energy Efficient Computing (TUCS)

Mandatory Courses	ECTS	Elective Courses	ECTS
Seminar on Energy Efficient Computing	5	Multi-Media Algorithm Implementation	5
Design methods for Energy Efficient Embedded Systems	5	System-on-Chip Design	5
Low-Power Circuit and System Design	5	Reconfigurable Computing	5
Many-Core Processor Programming	5	Seminar on Special Thematic Areas	5

		(Smart Spaces, Smart Energy Systems, Embedded Systems in Health and Well Being Applications)	
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Mobile Cyber-Physical Systems (Aalto)

Embedded systems project	5-10	Web software development	3-6
Augmented reality	4	Special assignment on embedded systems	5-8
Multimedia programming	4	Microsensors	5

Embedded Multicore Systems (TU Berlin)

Mandatory Courses	ECTS	Elective Courses	ECTS
Parallel Systems	6	Seminar Recent Advances in Computer Architecture	3
Multicore Architectures	6	Project Optimization of Multicore Systems	6
Analysis and Optimization of Embedded Systems	6	Operating Systems Project	9
One of the following seminars Recent Advances in Multicore Systems Optimization of Multicore Systems Hot Topics in Operating and Distributed Systems	3	Distributed Algorithms	6
One of the following team projects: Optimization of Multicore Systems Multicore Architectures for Embedded Systems	6		

A-4 Innovation and Entrepreneurship

The Innovation and Entrepreneurship courses at TU Eindhoven comprise 25 credit units are divided into the following categories:

1. Basic I&E courses worth 9 credit units: At TU Eindhoven these courses are Technology Entrepreneurship (1ZS01), Corporate Entrepreneurship (1ZS20) and New Media, Entrepreneurship and Innovation (1ZM80), each worth 3 credit units.
2. Business Development Laboratory worth 13 credit units: At TU Eindhoven, this comprises the courses Technology Entrepreneurship: Business Plan Development (1ZS02), worth 3 credit

units, Service Engineering and Marketing (1ZM55), worth 5 credit units, Capita Selecta Innovation and Entrepreneurship, worth 2 credit units and a Winter School for Business Development Lab, worth 3 credit units.

3. Summer school on Innovation and Entrepreneurship, worth 3 credit units.

Together with the 6 credit units for the innovation and Entrepreneurship Minor Thesis, the student takes 31 credit units worth of Innovation and Entrepreneurship modules.

A-5 Graduation Work

The graduation work comprises a (technical) graduation project worth 30 credit units and an innovation and entrepreneurship minor thesis, worth 6 credit units.

Graduation project consists of carrying out the final project, composing a graduation report, writing a summary of the report, and a presentation. Students may not commence the final project until they have successfully completed at least 80 credit units of their study program, and passed all the common base courses.