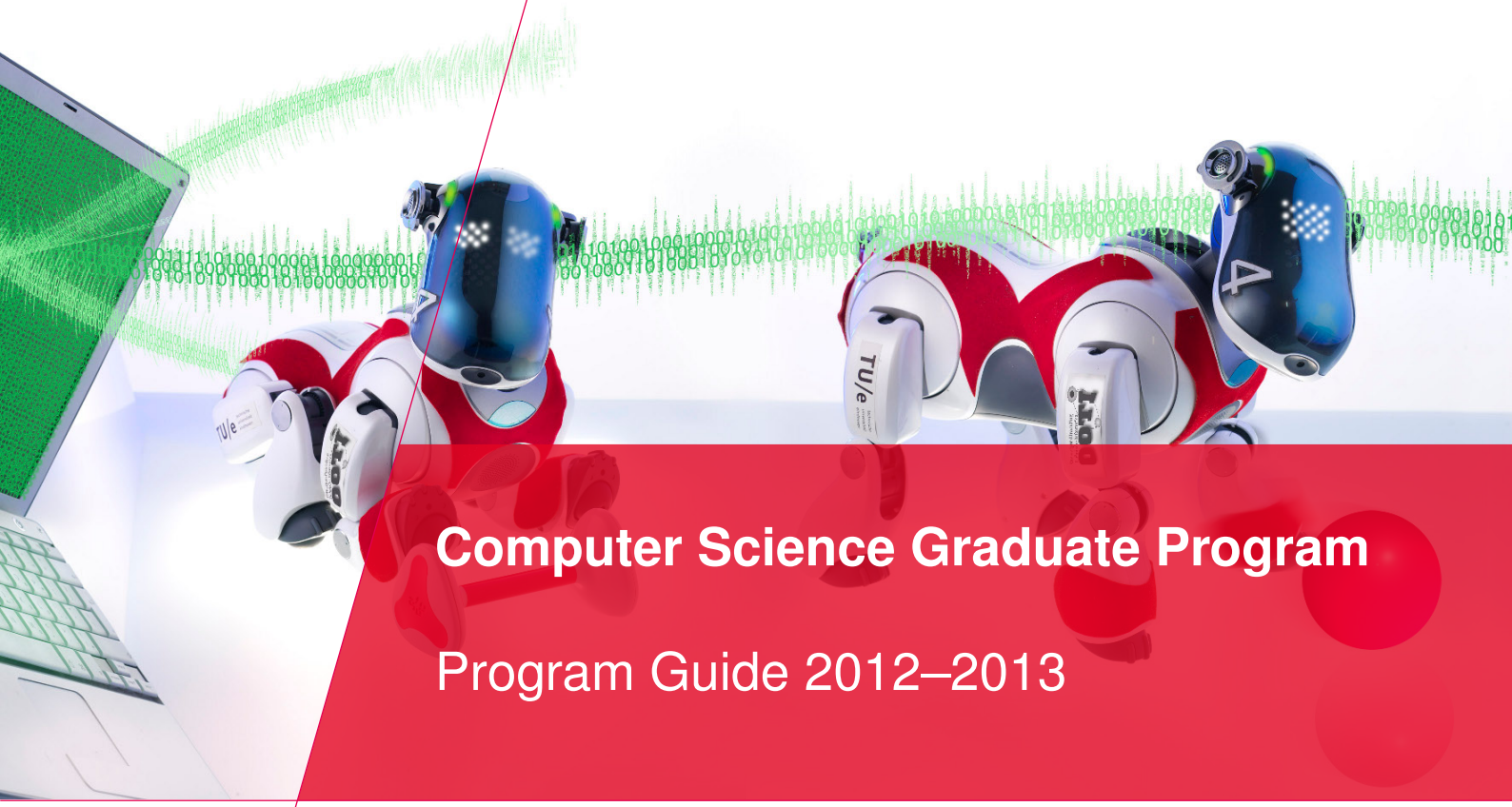
Department of Mathematics and Computer Science

Technische Universiteit
Eindhoven
University of Technology



Computer Science Graduate Program

Program Guide 2012–2013

Where innovation starts

Computer Science Graduate Program

Program Guide 2012–2013

Business Information Systems
Computer Science and Engineering
Embedded Systems
Information Security Technology
EIT Service Design and Engineering
EIT Embedded Systems

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Part I

General information

1 Studying in the Computer Science Graduate Program

The Department of Mathematics and Computer Science (W&I) at the Eindhoven University of Technology (TU/e) offers undergraduate (Bachelor of Science), graduate (Master of Science) and postgraduate (PhD, PDEng) courses in Computer Science and Applied Mathematics.

The Computer Science Division (CS) focuses on Specification and Verification, Algorithms and Visualization, Software and Systems Engineering, Information Systems, and Security. The CS Division offers its graduate and postgraduate courses in the Computer Science Graduate Program. There are four master programs, one of which is a specialization within the master program CSE:

- Computer Science and Engineering (CSE). This master program has a special track: Information Security Technology (IST), an interdisciplinary variant in cooperation with the Mathematics Division of the TU/e, the Radboud University Nijmegen, and the University of Twente.
- Business Information Systems (BIS), an interdisciplinary master program in cooperation with the Department of Industrial Engineering and Innovation Sciences (IE&IS).
- Embedded Systems (ES), an interdisciplinary master program in cooperation with the Department of Electrical Engineering (E).

and two postgraduate programs:

- Software Technology, a Master of Technological Design (PDEng) program,
- The PhD program.

The CS Division also contributes in the Computer Science specialization of the master program Science Education and Communication (SEC), offered by the Eindhoven School of Education (ESoE), see http://www.tue.nl/esoe. Graduates in the CS specialization from the program are entitled to teach computer science at Dutch high schools. Graduates from one of the above mentioned master programs will also be admitted to the SEC-program and are offered a one-year program. Since 2009, double-degree programs are offered for CSE & SEC (see Section 3.6), as well as for BIS & SEC (see Section 5.6), which comprise 150 credits.

1.1 Structure of the master programs

All programs comprise two years of study or 120 credit points (ects); a credit point is equivalent to 28 hours of study and homework for an average student. Most courses are standardized to 5 credit points per course.

The two years of course work and practical training are divided into three parts, consisting of:

1. Mandatory core courses to create a sufficient layer of theory and general or program-related knowledge.

2. Elective courses to prepare for the specialization.

3. Master project and thesis to be spent on a specialist topic of theoretical or practical nature. This part presents the opportunity to show your independent engineering and academic skills in research and design.

1.2 Lecture and interim examination periods

Each study year is divided into two semesters (September January and February July). Each semester consists of two quarters, each consisting of eight weeks of lectures followed by an examination period of two weeks. For details see the agendas and calendars at http://owinfo.tue.nl/.

Quarter	Period
1	September 3, 2012 – November 11, 2012
2	November 12, 2012 – February 3, 2013
3	February 4, 2013 – April 21, 2013
4	April 22, 2013 – July 7, 2013
interim	August 12, 2013 – August 17, 2013

1.3 Course and exam registration

Participation in a course is possible only if you have registered for the course via OASE. In the first quarter, the registration deadline is set at the end of the first lecture week. In the remaining quarters, this deadline is in the week before the lectures start. During the registration period, and in the first two lecture weeks, it is possible to withdraw from the course via studyweb yourself. Outside this period, you should contact the lecturer if you wish to withdraw.

Registration for a course does not constitute an automatic registration for the exam. You have to register for each exam separately via OASE (http://education.tue.nl/) before the set deadlines. Note that if you are not registered for an exam, you cannot take part in it.

1.4 Examination and titles

There is only one examination at the end of the program, in which the examination committee verifies and judges the final course results and the final master project grade. Completion of the program will lead to the title: Master of Science (MSc) with addition of the name of the program. Graduates are also entitled to use the Dutch title of ingenieur (ir).

1.5 Admissions

General and specific master program requirements are applicable to admissions. The specific requirements may be higher in terms of knowledge prerequisites, but may also provide more possibilities for entry for students from other related areas of specialization. The specific requirements for admission to each of the master programs are described in the corresponding chapters.

1.5.1 General admissions requirements

To be eligible for admission to any of the master programs, a Bachelor of Science degree is required. This degree must be of an equivalent academic level and approximate scientific content as the corresponding Dutch BSc degrees. In addition, sufficient proficiency in the English language is required.

1.5.2 Admissions with deficiencies

For admitted students from other universities, it may be necessary to repair deficiencies due to differences in programs. The admission committee will point out those so-called homologation courses to the students directly or via the study advisor.

Students coming from other disciplines at the three Dutch technical universities may be admissible after they followed a deficiency program of up to 30 credits. The disciplines in question are mentioned in the "3TU-doorstroommatrix", the corresponding deficiency program is constructed on an individual basis.

1.5.3 Foreign students

The applications of students with a foreign university BSc degree will be evaluated by the admissions committee, taking into account both the academic level of the degree and the subjects studied by the applicant. In some special cases, relevant work experience may also be considered. The level of the degree is determined by the NUFFIC (www.nuffic.nl).

1.5.4 Polytechnic graduates (HBO)

Students who have completed a polytechnic program may be eligible to participate in the pre-master programs. Completion of the pre-master program gives access to the corresponding master program. In Chapter 2 further details about admission for HBO students and the premaster program can be found.

1.5.5 Admissions procedure

The procedure to be followed depends on your particular situation. Detailed information on the application procedure can be found on the site of the Education and Student Service Center of the TU/e, http://w3.win.tue.nl/en/student/international_student_affairs/. Foreign students must be aware that the admissions procedure, including visa application and other formalities, may take a while.

1.6 Studying abroad

In case a student wants to study abroad as part of the program, several options are available for students with a Dutch Bachelor diploma:

- Take subjects at a foreign university
- Do an internship abroad
- Do the graduation project abroad

Consult the study advisor for programmatic issues. For organizational issues, the international affairs coordinator provides assistance. The contact person is E. van den Hurk bc., Room MF 3.068, International.office.win@tue.nl.

You need to deal with the organizational aspects yourself. The Education and Student Service desk has a handy checklist; it can be found on http://w3.tue.nl/en/

services/stu/. Information on scholarships can also be found at http://www.beursopener.nl/.

1.7 Honors program

The Honors program is aimed at excellent students from one of the Master programs offered by the Computer Science sub-department: Business Information Systems, Computer Science and Engineering, Information Security Technology, and Embedded Systems.

The goal of the program is to give these students the opportunity to participate in and contribute to the research being done at the department. Concretely, the Honors program consists of:

- Two projects for 6 ects each, one in semester 1B of the Master program and one in semester 2A. These projects can be research-oriented or design-oriented and are done in different research groups in the department. The exact contents of the projects is determined by the supervisor of the research group where the project is done, in consultation with the student. The expected outcome of the project is a paper (published as a technical report of the department, and possibly also elsewhere).
- Beside the projects, the student participates in other activities of the research group (for example in research seminars) and is encouraged to participate in activities organized by one of the national Dutch research schools (ASCI, IPA, or SIKS). The latter activities are typically short courses or conferences.

Note that the Honors program is done on top of the regular Master program, that is, the 12 ects do not count towards the 120 credits you need to accumulate for your Master program. Students who successfully complete the Honors program will receive a certificate upon graduation.

Participating in the Honors program is useful if you are interested in taking a PhD later on, since it allows you to experience what its like to do research in two different areas. But above all, the Honors program is challenging and fun.

The program is aimed at motivated and excellent students (among the top 10% of the Master students in the department) who had excellent grades in their Bachelor programs and scored high grades during the first semester of the Master program (average at least 8). For admission to the honors program, an application procedure applies. Detailed instructions for application and the deadline will be announced by e-mail to all students in February of each year.

More information about the honors program can be obtained from the honors program coordinator prof.dr. Mark de Berg, e-mail m.t.de.berg@tue.nl.

1.8 Internal quality assurance

After each semester the individual courses as well as the program are evaluated by the educational management and the study program committee. Based on this evaluation follow-up actions for improvement are defined if necessary.

Input for the evaluation sessions are statistical data on the examination results, and the aggregated results from the semester questionnaires for students. It is of vital importance that students cooperate in this respect since only questionnaires with a sufficient number of respondents are taken into consideration.

Apart from that, the examinations committee periodically carries out an investigation, in particular on the quality of the graduation projects and the quality of (partial) interim examinations.

The opinion of students on the quality of their graduation project and process is gathered by means of a graduation questionnaire, which is filled in after the assessment of the graduation project. These are collected and aggregated once a year. The results are discussed both in the study program committee and examinations committee.

1.9 Study advisor

The master study advisor for all programs is dr. Peter Veltkamp.

Office:	MF 3.066
E-mail:	j.p.veltkamp@tue.nl
Phone:	040 247 2763
Consulting hours:	Monday, Tuesday and Thursday from 17:00 to 18:00 (or later when necessary)

In case you are not able to visit the study advisor during his consulting hours, you can make an appointment for a meeting at another time.

1.10 After graduation

As an MSc graduate from the Computer Science Graduate Program, you are optimally prepared for a broad range of ICT-related jobs. However, you might consider to qualify yourself further for special jobs like system or software architect or for an academic career. In the latter case, the department of Mathematics and Computer Science offers the following opportunities.

1.10.1 Software Technology PDEng degree program

The Professional Doctorate in Engineering (PDEng) degree program in Software Technology is provided in the context of the 3TU School for Technological Design, the Stan Ackermans Institute.

It is an accredited and challenging two-year doctorate-level engineering degree program during which its trainees focus on strengthening their technical and non-technical competences related to the effective and efficient design and development of software-intensive systems, such as real-time embedded systems, in an industrial setting. The emphasis is on large-scale project-based design and development of this kind of software.

The various parts of the PDEng degree program aid to develop the capability of individuals to work within a professional context. It advocates a scientific research based approach to solving problems, a systematic way of collecting evidence and a critical, reflective, and independent mind for the analysis and interpretation of evidence.

It adds an additional dimension to a full MSc. program by extending it and integrating it with new elements. The emphasis is on developing and strengthening (exercising) the competencies necessary for finding technical solutions. For finding such solutions, an effective collaboration with representatives of different domains is inevitable, and this is practiced during the program. During the program, the PDEng trainees focus on systems architecting and designing software for software-intensive systems in multiple application domains for the High Tech Industry.

After successfully completing all requirements, trainees are awarded a Professional Doctorate in Engineering degree. More information can be found on: http://wwwooti.win.tue.nl/

1.10.2 PhD programs

When pursuing an academic career, the first step is to obtain a doctorate. A PhD program is an individual four year program, dedicated to sharpen your research skills. You are typically hired on a specific research project and become part of the scientific staff of the research group in which the project takes place. Your main task is to perform research under the guidance of and in collaboration with the supervisor(s) appointed by the Department. At the end of the four-year period, a PhD thesis is written on the research results. You do not only perform research, but also receive scientific training and training related to professional skills and personal development.

More information about PhD programs can be found on: http://www.tue.nl/en/education/tue-graduate-school/taking-a-phd/

2 Pre-master programs

2.1 Computer Science and Engineering

The pre-master program that a student with a completed polytechnic program of computer science has to follow consists of the following units:

Quarter	Code	Unit	ECTS
		Dutch program	
1	2IJ26	Algebra	3
1 or 2	2IT60	Logic and set theory	5
1 or 3	2DL03	Basic mathematics	3
1 or 3	2DL06	Linear algebra	3
2	2ID05	Datamodeling and databases	6
2 or 4	2DL04	Calculus A	3
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
		English program	
1	2IJ26	Algebra	3
1	2WAB0	Calculus variant A	5
1 or 2	2IT60	Logic and set theory	5
2	2ID05	Datamodeling and databases	6
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
2 or 4	2DL07	Statistics A	3

Students taking the pre-master program are required to include some units of the bachelor program "Technische Informatica" as homologation units in the elective part of the master program:

Quarter	Code	Unit	ECTS
		Dutch program	
2 or 4	2DL07	Statistiek A	3
3	2IL50	Data structures	5
		English program	
3	2DE20	Mathematics 1	5
3	2IL50	Data structures	5

2.2 Business Information Systems

The pre-master program that a student with a completed polytechnic program of computer science has to follow consists of the following units of in total 30 credit points:

Quarter	Code	Unit	ECTS
		Dutch program	
1 or 2	2IT60	Logic and set theory	5
1 or 3	2DL03	Basic mathematics	3
1 or 3	2DL06	Linear algebra	3
2	2ID05	Datamodeling and databases	6
2 or 4	2DL04	Calculus A	3
2 or 4	2DL07	Statistiek A	3
1 (or 4)	2II07 (or 2II05)	Business information systems	6
		English program	
1	2WAB0	Calculus variant A	5
1 or 2	2IT60	Logic and set theory	5
2	2ID05	Datamodeling and databases	6
2 or 4	2DL07	Statistics A	3
3	2DE20	Mathematics 1	5
1 (or 4)	2II07 (or 2II05)	Business information systems	6

Students taking the pre-master program are required to include some units of the bachelor program "Technische Informatica" as homologation units in the elective part of the master program:

Quarter	Code	Unit	ECTS
		Dutch program	
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
One of the following			
1	2DD27	Stochastic operations research	3
2	2DD21	Pre-master stochastic operations research 3	
		English program	
2	2DD21	Pre-master stochastic operations research 3	
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)

2.3 Information Security Technology

The pre-master program that a student with a completed polytechnic program of computer science has to follow consists of the following units:

Quarter	Code	Unit	ECTS
		Dutch program	
1 or 2	2IT60	Logic and set theory	5
1 or 3	2DL03	Basic mathematics	3
1 or 3	2DL06	Linear algebra	3
2	2ID05	Datamodeling and databases	6
2 or 4	2DL04	Calculus A	3
2 or 4	2DL07	Statistics A	3
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
		English program	
1	2WAB0	Calculus variant A	5
1 or 2	2IT60	Logic and set theory	5
2	2ID05	Datamodeling and databases	6
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
2 or 4	2DL07	Statistics A	3
3	2DE20	Mathematics 1	5

Students taking the pre-master program are required to include some units of the bachelor program "Technische Informatica" as homologation units in the elective part of the master program:

Quarter	Code	Unit	ECTS
		Dutch program	
1	2IT27	Discrete structures*	5
3	2IL50	Data structures	5
		English program	
1	2IT27	Discrete structures*	5
3	2IL50	Data structures	5

2.4 Embedded Systems

The pre-master program that a student with a completed polytechnic program of computer science has to follow consists of the following units:

Quarter	Code	Unit	ECTS
		Dutch program	
1 or 2	2IT60	Logic and set theory	5
1 or 3	2DL03	Basic mathematics	3
1 or 3	2DL06	Linear algebra	3
1	5DD17	Circuit analysis	3
1-2	5HH30	Digital signal processing	3
2 or 4	2DL04	Calculus A	3
2 or 4	2DL07	Statistics A	3
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
		English program	
1	2WAB0	Calculus variant A	5
1	5DD17	Circuit analysis	3
1 or 2	2IT60	Logic and set theory	5
1-2	5HH30	Digital signal processing	3
2 (or 4)	2IT15 (or 2IT70)	Automata and process theory	6 (or 5)
2 or 4	2DL07	Statistics A	3
3	2DE20	Mathematics 1	5

Students taking the pre-master program are required to include some units of the bachelor program "Technische Informatica" as homologation units in the elective part of the master program:

Quarter	Code	Unit	ECTS
1	2IW05	Software specification	6
2	2IL65	Algorithms	3
2	5HH00	Electronics for embedded systems	3
4	5JJ50	Computational networks	3

2.5 Information sources

Study advisor: dr. C.J. (Roel) Bloo, MF 3.067, phone 040 247 4496
Coordinator: ms. E. (Elisabeth) Melby, e-mail: e.melby@tue.nl, MF 3.094, phone 040 247 5150

Part II

Master Programs

3 Computer Science and Engineering

The Master program in Computer Science and Engineering (CSE) is a flexible program, giving a broad view of computer science from both a scientific and an engineering perspective. The program consists of a small number of core subjects, and provides ample opportunities for specialization and shaping the program to your interests. As a graduate, you will be able to play a leading role in developments in your field, whether scientific research, industry, commerce, or government.

The Computer Science and Engineering program allows you to specialize in the areas Algorithms, Visualization, Architecture of Information Systems, Databases and Hypermedia, Formal System Analysis, Software Engineering Technology, System Architecture and Networks, and Security.

3.1 Admission

A Bachelor degree in Computer Science obtained at a Dutch university provides direct admission to the CSE program. Students with a different degree and from foreign universities have to apply for admission via the admission committee. Dutch HBO graduates have to take a pre-master program before they can be admitted, see Section 2.1.

The admission procedure is described in Section 1.5, and the requirements are listed in the Teaching and Examination Regulations (see Appendix A.1).

3.2 Goals

After the master program, the graduates will have the following competences:

1. (a) In-depth knowledge of the foundations of computer science.

(b) Insight into formalisms, methods, tools and their mutual relations.

(c) Insight into the relationships within the field of computer science and the power to follow important topical developments within the field.

2. (a) Be capable of designing or redesigning complex computerized systems in a structured way, to allow these systems to carry out their tasks in a correct and efficient way.

   (b) Have sufficient insight into the principles of design methods to make an argued choice for a specific methodology for a concrete situation.

3. Be capable of carrying out research assignments in a responsible scientific fashion and be able to report about the assignments.

3.3 Curriculum

The Master program Computer Science and Engineering is a two-year program of 120 ECTS in total. The academic year is subdivided into two semesters, the fall semester starting in September, and the spring semester starting in February. It is possible to enter the program in either semester; however, starting in September is preferred. The program is full time.

The global structure of the program is as follows:

Study component	Credits
Core program	25
Electives	60
Research seminar	5
Master project	30

3.3.1 Core program

The core courses provide you with a sound theoretical basis. This mandatory part of the Master program consists of a choice of five courses from each of the specialization areas. Each research group offers a core course. Additionally, you should follow a research seminar in your specialization (see Chapter 7) to prepare for your master project. Each of the eight computer science research groups offers a seminar, in which typical topics for that particular field of research are addressed.

Quarter	Code	Unit	ECTS	Exam
		Core courses		
1	2IL45	Advanced algorithms	5	a
1	2IN26	Real-time systems	5	w+a

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Quarter	Code	Unit	ECTS	Exam
1	2IS15	Generic language technology	5	w+a
1	2IV35	Visualization	5	a
3	2IW26	System validation	5	w+a
3	2ID45	Advanced databases	5	w+a
3	2II55	Business process management systems	5	w+a
3–4	2IF02	Verification of security protocols	6	w+a
		Seminars		
1	2IF96	Seminar formal system analysis*	5	a
2	2II96	Seminar architecture of information systems	5	a
2	2ID95	Seminar databases and hypermedia	5	a
2	2IL95	Seminar algorithms*	5	a
2	2IN95	Seminar systems architecture and networking	5	a
2	2IS95	Seminar software engineering and technology	5	a
2	2IV95	Seminar visualization	5	a
3–4	2IF03	Seminar information security technology	6	a
4	2IF96	Seminar formal system analysis	5	a
4	2IL95	Seminar algorithms	5	a

*) The seminars 2IF96 and 2IL95 are offered twice in the academic year 2012–2013 only. From 2013–2014 onwards, they are only offered in quarter 4.

3.3.2 Electives

The elective part of the curriculum amounts to 60 credits and it consists mainly of courses. In general, courses can be chosen freely from the list provided this section and from curricular courses in the other computer science programs. To compose a balanced program, you should consult the contact person of the specialization of your interest (see Section 3.3.3).

Some courses may be prescribed as homologation courses (up to 18 credits) to make up for deficiencies in former education. Other courses may only be selected after approval by the Examinations Committee in advance (please consult the master study advisor). In some cases an internship of 15 credits may be part of the electives, see Section 3.3.4.

Quarter	Code	Unit	ECTS	Exam
1	2IC35	Physical aspects of digital security	5	w
1	2ID25	Information retrieval	5	w+a
1	2ID55	Adaptive systems	5	a
1	2II65	Metamodeling and interoperability	5	w+a
1	2IL45	Advanced algorithms	5	a
1	2IN26	Real-time systems	5	w+a
1	2IN28	Grid and cloud computing	5	a

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Quarter	Code	Unit	ECTS	Exam
1	2IS15	Generic language technology	5	w+a
1	2IV35	Visualization	5	a
1	2IW55	Algorithms for model checking	5	w+a
1	5ME20	Ubiquitous computing and activity recognition	5	a
1–2	2IF17	Hackers hut	6	a
1–2	5KK73	Embedded computer architecture	5	o
1–2	9ST14	Academic skills in English 1	4	w+o
2	2IF35	Formal modeling in cell biology	5	a
2	2IF85	Program verification techniques	5	w+a
2	2II35	Web information systems	5	w+a
2	2II45	Architecture of distributed systems	5	w+a
2	2II70	Constraint programming	5	a
2	2IL55	Geometric algorithms	5	a
3	2IN27	Quantitative evaluation of embedded systems	5	w+a
2	2IS25	Distributed trust management	5	w+a
2	2IS26	Model-based software and system engineering	5	w+a
2	2IV55	Interactive virtual environments	5	a
2	2IW15	Automated reasoning	5	w+a
3	1BM46	Data mining and process mining	5	a
3	2ID45	Advanced databases	5	w+a
3	2IF65	Proving with computer assistance	5	w+a
3	2II55	Business process management systems	5	w+a
3	2IL75	Algorithms for massive data	5	a
3	2IS55	Software evolution	5	a
3	2IV05	Additional component computer graphics	5	a
3	5KK06	Computer arithmetic	5	w+a
3	2IW04	Knowledge based control systems	5	w+a
3	2IW26	System validation	5	w+a
3–4	1BM41	Business information systems architecture	5	w+a
3–4	2IF02	Verification of security protocols	6	w+a
3–4	2WO08	Graphs and algorithms	6	w
3–4	5P480	Knowledge systems and applications	4	o
3–4	9ST14	Academic skills in English 1	4	w+o
4	2ID35	Database technology	5	w+a
4	2IF45	Process algebra	5	w+a
4	2II75	Business process simulation	5	a
4	2IN35	VLSI programming	5	a
4	2IP45	Software project management	5	a
4	2IV15	Simulation in computer graphics	5	a
4	2IW02	Real-time software development	5	a
4	2WO07	Approximation algorithms	3	a
4	2IW45	Programming by calculation	5	a
4	5N520	Statistical bioinformatics	2	o

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Quarter	Code	Unit	ECTS	Exam
1	2IUU1	Intelligent agents	7.5	w
2	2IUU2	Multi-agent systems	7.5	w+a
2	2IUU3	Computer animation	7.5	a
2	2IUU4	Computer vision	7.5	w+a
4	2IUU5	Games and agents	7.5	a
	2IF98	Capita selecta formal system analysis	5	a
	2IS99	Capita selecta software engineering and technology	5	a
	2IC99	Capita selecta security	5	a
	2IL99	Capita selecta algorithms	5	a
	2IN99	Capita selecta systems architecture and networking	5	a
	2IV99	Capita selecta visualization	5	a
	2ID99	Capita selecta databases and hypermedia	5	a
	2II99	Capita selecta architecture of information systems	5	a
	2IM02	Internship	15	a

3.3.3 Specializations

The CS division has eight research groups (see details and the names of contact persons in Chapter 7), each offering specialization courses in addition to their core course.

After taking some courses, you will probably have a more clear picture of the academic direction you want to pursue in your studies. If not, you may want to talk to several staff members or the study advisor. In the specialization for your subject, there are people that you may want to be involved with for your final master project. In order to compose a well-balanced program that provides adequate prerequisites for the this project, it is advisable to first choose and consult a project supervisor in the specialization of your interest before choosing elective courses.

As a rule of thumb, you should start your search for a supervisor and the construction of your individual program not later than at the end of your first year.

3.3.4 Internship

Since the master project can already be performed in an industrial environment, it is usually advised to spend the rest of the study program on regular courses. In some cases, however, an internship may be a valuable addition to the program, provided that it enhances practical experience, provides deepening of knowledge, and contributes to the specialization. An internship takes 15 credit points as part of the electives, and can be followed only by permission of the internship coordinator. The internship is not open to IST-students. Requests for internships accompanied by convincing arguments explaining the reasons why the intended internship has a clear added value to the study program are to be sent to the internship coordinator dr. J.P. Veltkamp.

3.3.5 Admission to seminars, capita selecta, master project

Capita selecta courses are occasional educational elements, often with a research flavor. They may be experimental courses, a lecture series given by a visitor, or a special individual assignment as a preparation on future research. The capita selecta can be followed only by permission of the responsible lecturer. Students do not have a "right" to do these courses, but they may be granted the possibility.

The seminars, capita selecta, and master project are only open to students that are fully admitted. This means that they are not available for students that do not yet have their BSc diploma or students that did not yet complete the premaster. Other students that have deficiencies (e.g. uncompleted homologation courses) cannot start the master project.

3.4 Approval of study program

The Examinations Committee must approve your program consisting of the mandatory courses and your choice of the electives. In order to obtain this approval you construct a program, possibly with the help of the study advisor, fill out the program form, have it signed by yourself and the supervisor of your choice and hand it in at the student administration office (MF 3.068).

3.5 Final project

The final project of 30 credit points can be completed in any of the research groups in the CS-division, as long as a CS staff member is supervising it.

The start of your master project is marked by submitting a completed graduation plan containing the necessary information on the project (name, place, period, supervisor, and so on), and stating the fact that you have completed your curricular part of the program (see Section 3.4). The form must be accompanied by a project description and signed by you, your supervisor, the head of the relevant specialization and the study advisor.

3.5.1 Admission

During the master project, you should be able to spend full time and concentration on your project. In practice, however, it turns out to be rather difficult to plan curricular activities and, especially, their success. Therefore, we leave room for at most two courses of in total at most ten credit points to be finished during the master project period. Courses that are to be taken as homologation units have to be passed before you can start the master project. Also, be aware that you are not allowed to finish your project before you completed all your courses.

3.5.2 Planning

Together with your supervisor, you decide on a description of your topic and a global planning. You also arrange the supervision method, including how often you and your supervisor will meet to discuss progress. The project is concluded with a thesis and a presentation followed by a defense.

In general, the master project has to be finished within 6 months from the start. An extension to 9 months is possible. In exceptional cases, and only if it is clear that the project can be finished, the exam committee may allow for an additional 3 months period. It is important to note that the project must be finished within 1 year (when working full time) to prevent cancellation of the project, and having to start a new project with a different supervisor. The graduation regulations can be found on the website.

3.5.3 Assessment

Your final project is graded by an assessment committee. The committee usually consists of your supervisor, a staff member from your specialization area, and a staff member from one of the other CS research groups. The supervisor is responsible for forming this committee at least one month before graduation.

The assessment committee takes the following criteria into account:

Report:	Structure, completeness, correctness, readability, argumentation.
Graduation presentation:	Structure, contents, clarity, contact with audience.
Defense:	Argumentation, demonstration of knowledge, competency in discerning main aspects from details of the project.
Execution of the project:	Level of independence, planning, organization, handling deadlines and setbacks, level of own contribution.

Not all criteria are equally important. The assessment committee decides the relative importance of each criterion to arrive at a final grade. The motivation for the grade is documented in an assessment report.

3.5.4 Checklist

The graduation checklist (Appendix B) summarizes all the steps required from having your study program approved to the graduation ceremony.

3.6 Double degree program CSE and SEC

The qualification to teach computer science to senior secondary school pupils is coupled to the 3TU program Science Education and Communication (SEC). This program encompasses 120 credits. In Eindhoven it is offered by the Eindhoven School of Education (ESoE). In the Education track of the SEC program, a student specializes in one

of four disciplines: maths, physics, chemistry or computer science. Please note that the SEC program is completely lectured in Dutch!

BSc graduates in computer science are directly admitted to the SEC-program. So are MSc graduates from a computer science oriented program; their SEC-program is reduced to 60 credits because of exemptions. For this last category an even shorter route is available by taking the double degree program, which amounts up to 150 credits. Enrollment is required for both master programs (one main enrollment and a second enrollment). Certificates will be granted after completion of the whole program.

Details about the curriculum are available at the ESoE website: http://www.tue.nl/esoe/.

4

Information Security Technology

A Master of Science in Information Security Technology (IST) is an academic expert in the area of digital communication in general, and in information security technology in particular. Information security technology protects data that are stored, transmitted, accessed, or modified against all kinds of threats. This can vary from unauthorized access to malicious manipulations. Information security technology is essential for secure communication and data protection in many situations.

The IST program is a joint master program between three Dutch universities: Eindhoven University of Technology (TU/e), Radboud University Nijmegen (RU), and University of Twente (UT). These three universities have joint their forces with respect to security education in the Kerckhoffs Institute.

Each of the mandatory and special elective courses is taught at only one of these three universities. This implies that students have to travel to other sites for part of their education. The program is set up in such a way that averaged over the two years of their master's studies students will have to travel one day per week to another university.

A Master of Science in Information Security Technology can become involved in cryptographic primitives, security protocols, data storage, communication, or information security management. Additionally, he or she can act as internal or external consultant, regarding the security of information systems and networks, or regarding the security policy of an organization. A Master of Science in Information Security Technology can enter a job in the following institutions: research laboratories and academic institutes (both for theoretical and applied work); applied R&D in industry; the financial world; governmental agencies; consultancy agencies (all with respect to security in the area of information systems and relevant policymaking).

4.1 Admission

A Bachelor degree in Computer Science obtained at a Dutch university provides direct admission to the CSE program. Students with a different degree and from foreign universities have to apply for admission via the admission committee. Dutch HBO graduates have to take a pre-master program before they can be admitted, see Section 2.3.

The admission procedure is described in Section 1.5, and the requirements are listed in the Teaching and Examination Regulations (see Appendix A.1).

4.2 Goals

The goal of the program is to transform Bachelors in Computer Science and Mathematics into academic experts in the area of digital communication in general and in information security in particular. Alumni will be able to function as researcher or as system developer in university or society. They will be well aware of the state-of-the-art in information security technology at the master level. They will be able to analyze complex security situations and to reduce them to solvable problems.

More specifically, after completion of the program, the student

- should have a scientific attitude
- should have acquired the necessary engineering skills
- should be able to expand his expertise in the field
- has a broad view of information security
- should be able to evaluate existing and newly designed security systems
- should be able to list relevant security requirements in an application and to select the right techniques to address these issues
- is an expert in at least one subarea of information security
- can contribute to discussions about the role of information security in our society
- has experience in the process of specifying, designing, and realisation of an application in which security plays an important role
- is skilled in properly documenting and presenting results

4.3 Curriculum

The Master track Information Security Technology is a two-year program of 120 ECTS in total. The academic year is subdivided into two semesters, the fall semester starting in September, and the spring semester starting in February. It is only possible to enter the program September. The program is full time. The curriculum contains both computer science courses and mathematics courses, and consists of a mandatory core program and elective courses.

4.3.1 Core program

The mandatory part of the program contains the following courses:

Quarter	Code	Unit	ECTS	Location
		First year		
1-2	2IF08	Network security	6	Twente
1-2	2WC12	Cryptography 1	6	Eindhoven
3-4	2IF02	Verification of security protocols	6	Eindhoven
3-4	2IF06	Software security	6	Nijmegen
		Second year		
1-2	2IF19	Security and privacy in mobile systems	6	Twente
1-2	2IF07	Security in organizations	6	Nijmegen
3-4	2IM91 / 2H016	Master project *	30	

*) In case the master project is done within the Mathematics Division the code is 2H016.

4.3.2 Electives

The list below contains the preferred electives for the IST program. It is also possible to choose electives from the CSE program (see Section 3.3.2); an internship (2IM02) is not possible however. At least three courses must be chosen from the following list of preferred electives:

Quarter	Code	Unit	ECTS	Location
		First year		
1-2	2IF09	Biometric recognition	6	Twente
1-2	2IF18	Cyber crime Science	6	Twente
1-2	2IF17	Hackers hut	6	Eindhoven
3-4	2IF03	Seminar information security technology	6	Eindhoven
3-4	2IF13	Privacy seminar	6	Nijmegen
3-4	2WC13	Cryptography 2	6	Eindhoven
		Second year		
1-2	2IF12	Law in cyberspace	6	Nijmegen
1-2	2IF14	Hardware and operating system security	6	Nijmegen
1-2	2IF15	Secure data management	6	Twente

4.3.3 Admission to seminars, capita selecta, master project

Capita selecta courses are occasional educational elements, often with a research flavor. They may be experimental courses, a lecture series given by a visitor, or a special individual assignment as a preparation on future research. The capita selecta can be

followed only by permission of the responsible lecturer. Students do not have a "right" to do these courses, but they may be granted the possibility.

The seminars, capita selecta, and master project are only open to students that are fully admitted. This means that they are not available for students that do not yet have their BSc diploma or students that did not yet complete the premaster. Other students that have deficiencies (e.g. uncompleted homologation courses) cannot start the master project.

4.4 Approval of study program

The Examinations Committee must approve your program consisting of the mandatory courses and your choice of the electives. In order to obtain this approval you construct a program, possibly with the help of the study advisor, fill out the program form, have it signed by yourself and the supervisor of your choice and hand it in at the student administration office (MF 3.068).

4.5 Final project

The start of your master project is marked by submitting a completed graduation plan containing the necessary information on the project (name, place, period, supervisor, and so on), and stating the fact that you have completed your curricular part of the program (see Section 4.4). The form must be accompanied by a project description and signed by you, your supervisor, the head of the relevant specialization and the study advisor.

4.5.1 Admission

During the master project, you should be able to spend full time and concentration on your project. In practice, however, it turns out to be rather difficult to plan curricular activities and, especially, their success. Therefore, we leave room for at most two courses of in total at most ten credit points to be finished during the master project period. Courses that are to be taken as homologation units have to be passed before you can start the master project. Also, be aware that you are not allowed to finish your project before you completed all your courses.

4.5.2 Planning

Together with your supervisor, you decide on a description of your topic and a global planning. You also arrange the supervision method, including how often you and your supervisor will meet to discuss progress. The project is concluded with a thesis and a presentation followed by a defense.

In general, the master project has to be finished within 6 months from the start. An extension to 9 months is possible. In exceptional cases, and only if it is clear that the project can be finished, the exam committee may allow for an additional 3 months period. It is important to note that the project must be finished within 1 year (when working full time) to prevent cancellation of the project, and having to start a new project with a different supervisor. The graduation regulations can be found on the website.

4.5.3 Assessment

Your final project is graded by an assessment committee. The committee usually consists of your supervisor, a staff member from your specialization area, and a staff member from one of the other CS research groups. The supervisor is responsible for forming this committee at least one month before graduation.

The assessment committee takes the following criteria into account:

Report:	Structure, completeness, correctness, readability, argumentation.
Graduation presentation:	Structure, contents, clarity, contact with audience.
Defense:	Argumentation, demonstration of knowledge, competency in discerning main aspects from details of the project.
Execution of the project:	Level of independence, planning, organization, handling deadlines and setbacks, level of own contribution.

Not all criteria are equally important. The assessment committee decides the relative importance of each criterion to arrive at a final grade. The motivation for the grade is documented in an assessment report.

4.5.4 Checklist

The graduation checklist (Appendix B) summarizes all the steps required from having your study program approved to the graduation ceremony.

5 Business Information Systems

The Department of Mathematics and Computer Science and the Department of Industrial Engineering and Innovation Sciences play an active role in the development of new, innovative and application-oriented technology. The cooperation between the Information Systems section within Computer Science and the Information Systems section within Industrial Engineering and Innovation Sciences is long established and fruitful. The master program in Business Information Systems (BIS) at TU/e is illustrative of these cooperative efforts.

The program rests on a sound theoretical foundation, with emphasis on the design and application of quality business information systems and technology for information systems. As a graduate of this program, the student will have developed a scientific attitude and a model-driven, engineering approach to the field. The student is trained in the use of formal models allowing for specification analysis. The area of expertise will be the development of business information systems from a business perspective. The student will be able to play a leading role in the development and application of business information systems in various sections of society (profit and non-profit).

5.1 Admission

A Bachelor degree in Computer Science or in Industrial Engineering obtained at a Dutch university provides direct admission to the BIS program. Students with a different degree and from foreign universities have to apply for admission via the admission committee. Dutch HBO graduates have to take a pre-master program before they can be admitted, see Section 2.2.

The admission procedure is described in Section 1.5, and the requirements are listed in the Teaching and Examination Regulations (see Appendix A.2).

5.2 Goals

At the end of his academic studies, in addition to the qualities mentioned in article 1.3 of the Education and Examination Regulations (see Appendix A.2), the master student will have developed:

- An academic attitude through:
  - independent knowledge acquisition
  - critical bearing and perception
  - originality in research and responsible reporting thereof
  - methodical approach
- An engineering attitude through:
  - design skills
  - application directedness and multi-disciplinarity
  - presentation and documentation skills
  - insight into the industrial and managerial context of the field
  - mathematical flavour with emphasis on correctness dependability and the use of formal methods in design and construction
- Comprehension of the role of IT in the context of organizations and business processes through:
  - knowledge and skills specific for business information systems: formalisms, methods, tools and their mutual dependencies
  - knowledge of application areas
  - emphasis on general applicative knowledge, insights, methods and principles, that are considered more important than encyclopaedic factual knowledge and application-dependent or time-related aspects

Graduates will be technical academics with a high level of abstraction and extensive technical knowledge and highly developed capabilities for analysis, synthesis and design.

5.3 Curriculum

The Master program Business Information Systems is a two-year program of 120 ECTS in total. The academic year is subdivided into two semesters, the fall semester starting in September, and the spring semester starting in February. It is possible to enter the program in either semester; however, starting in September is preferred. The program is full time.

The curriculum consists of computer science courses and courses in industrial engineering. All students take the core program, choose a stream package, and complete the program with electives.

5.3.1 Core program

The core program is mandatory for all students.

Quarter	Code	Unit	ECTS	Exam
1	2ID25	Information retrieval	5	w+a
1-2	1BM05	Business process management	5	w+a
1-2	1BM10	Electronic business architectures and systems	5	a+o
1-2	1BM20	Software requirements management: quality and functionality	5	w+a
2	2II35	Web information systems	5	w+a
3	2II55	Business process management systems	5	w+a
3-4	1BM65	IT-governance	5	w+a
4	2ID35	Database technology	5	w+a
4	2II75	Business process simulation	5	a
		Stream courses and electives	**45**	
3-4	**2IM91**	**Master project**	**30**	a

5.3.2 Streams

Streams are introduced in order to distinguish between various profiles within the BIS program. In principle, one of the following four stream packages has to be chosen as part of the program. Departure from this rule needs the approval of the program director. A request for departure should include a thorough motivation of the student.

Quarter	Code	Unit	ECTS	Exam
		Business Process Management (B)		
1	2II65	Metamodeling and interoperability	5	w+a
3	1BM46	Data mining and process mining	5	a
3-4	1BM16	Executable models of operational processes	5	a
		Health Care (H)		
1-2	1BM70	Healthcare business networks	5	a+o
Choose at least 10 credits from:				
1	0EM60	Perspectives on medical technology	3	o
3	1BM46	Data mining and process mining	5	a
3-4	1JM06	Human aspects of innovation	5	a

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Quarter	Code	Unit	ECTS	Exam
3-4	1JM27	Human performance in innovative organizations	5	a
		ICT Services (I)		
1-2	1BM70	Healthcare business networks	5	a+o
2	2II45	Architecture of distributed systems	5	w+a
3-4	1BM41	Business information systems architecture	5	w+a
		Logistics (L)		
1-2	1BM62	Enterprise information systems	5	w+a
1-2	1CM10	Modeling and analysis of manufacturing systems	5	a
1-2	1CM50	Production and inventory control*	6	w
3-4	1CM25	Supply chain operations planning	5	w+a

*) Not for students who have a Bachelor degree in "Technische Bedrijfskunde".

5.3.3 Preferred electives

The elective part of the curriculum consists mainly of courses. In general, courses can be chosen freely from the lists provided this section and Section 5.3.4. Some courses, up to a maximum of 18 credits, may be prescribed as homologation courses to make up for deficiencies in former education.

As a rule, the courses 2II07 and 2DD21 are presented as homologation courses for students with an external bachelor degree. Other courses may only be selected after approval by the examinations committee in advance (you may consult the study advisor). In some cases, an internship of 15 credits may be part of the electives.

The following table outlines a collection of courses, and their relevance to the streams. Some components are already part of a stream package (indicated in a bold font). Items on this list can be selected as elective without prior approval of the Examinations Committee.

Quarter	Code	Unit	ECTS	Exam	Streams		
1	0EM60	Perspectives on medical technology	3	o		**H**	
1	2ID55	Adaptive systems	5	a	B	I	
1	2II65	Metamodeling and interoperability	5	w+a	**B**	H	
1	2IS15	Generic language technology	5	w+a	B		
1	2IV35	Visualization	5	a	B	H	
1-2	1BM62	Enterprise information systems	5	w+a	B	I	**L**
1-2	1BM70	Healthcare business networks	5	a+o	B	**H**	**I**
1-2	1CM05	Design of operations planning and control systems	5	a			L
1-2	1CM10	Modeling and analysis of manufacturing systems	5	a			**L**

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Quarter	Code	Unit	ECTS	Exam	Streams		
1-2	1CM40	Retail operations	5	w+a			L
1-2	1CM50	Production and inventory control	6	w			**L**
2	2IF85	Program verification techniques	5	w+a	B		
2	2II45	Architecture of distributed systems	5	w+a	B	**I**	
2	2II70	Constraint programming	5	a	B		L
3	1BM46	Data mining and process mining	5	a	**B**	**H**	I
3	2ID45	Advanced databases	5	w+a	B		
3	2IW26	System validation	5	w+a	B	I	
3-4	1BM16	Executable models of operational processes	5	a	**B**		L
3-4	1BM41	Business information systems architecture	5	w+a		H	**I**
3-4	1CM15	Project and process management	5	a			L
3-4	1CM25	Supply chain operations planning	5	w+a			**L**
3-4	1CM30	Service supply chain for capital goods	5	w			L
3-4	1CM36	Game theory with applications to supply chain management	5	w		I	L
3-4	1JM06	Human aspects of innovation	5	a		**H**	
3-4	1JM27	Human performance in innovative organizations	5	a	B		
4	2IP45	Software project management	5	a		I	
		Seminars					
2	2ID95	Seminar databases and hypermedia	5	a	B	H	
2	2II96	Seminar architecture of information systems	5	a	B	H	
		Capita selecta					
	2ID99	Capita selecta databases and hypermedia	5	a	B		
	2II99	Capita selecta architecture of information systems	5	a	B		

5.3.4 Other electives

The following table outlines a collection of courses, which can be selected as elective without prior approval of the Examinations Committee.

Quarter	Code	Unit	ECTS	Exam
1	2IC35	Physical aspects of digital security	5	w
1	2IL45	Advanced algorithms	5	a
1	2IN26	Real-time systems	5	w+a
1	2IN28	Grid and cloud computing	5	a

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Quarter	Code	Unit	ECTS	Exam
1	2IW55	Algorithms for model checking	5	w+a
1-2	1BM95	Literature study for BIS-students*	5	a
1-2	1JM11	Performance enhancement	5	w+a
1-2	1ZM16	Management of product development	5	w+a
1-2	1ZM45	International negotiation	3	w+a
2	1CM45	Business economics and management accounting for BIS	4	w+a
2	2IL55	Geometric algorithms	5	a
2	2IN27	Quantitative evaluation of embedded systems	5	w+a
2	2IS25	Distributed trust management	5	w+a
2	2IS26	Model-based software and system engineering	5	w+a
2	2IW15	Automated reasoning	5	w+a
2	2IV55	Interactive virtual environments	5	a
3	2IF65	Proving with computer assistance	5	w+a
3	2IL75	Algorithms for massive data	5	a
3	2IS55	Software evolution	5	a
3	2IV05	Additional component computer graphics	5	a
3-4	1BM95	Literature study for BIS-students	5	a
3-4	1CM22	Integrated financial & operations management	5	w
3-4	1JM21	Designing effective performance management systems	5	w+a
3-4	1ZM20	Technology entrepreneurship	5	w+a
3-4	1ZM25	Knowledge processes and management	5	a
3-4	1ZM35	Strategic sourcing and supply management	5	a
3-4	1ZM40	Strategy and technology management	5	a
3-4	1ZM45	International negotiation	3	w+a
3-4	2IF02	Verification of security protocols	6	w
4	2IF45	Process algebra	5	w+a
4	2IN35	VLSI programming	5	a
4	2IV15	Simulation in computer graphics	5	a
4	2IW45	Programming by calculation	5	a
1	2IF96	Seminar formal system analysis	5	a
2	2IL95	Seminar algorithms	5	a
2	2IN95	Seminar systems architecture and networking	5	a
2	2IS95	Seminar software engineering and technology	5	a
2	2IV95	Seminar visualization	5	a
3-4	2IF03	Seminar information security technology	6	a
4	2IF96	Seminar formal system analysis	5	a
4	2IL95	Seminar algorithms	5	a
	2IF98	Capita selecta formal system analysis	5	a
	2IS99	Capita selecta software engineering and technology	5	a
	2IC99	Capita selecta security	5	a

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Quarter	Code	Unit	ECTS	Exam
	2IL99	Capita selecta algorithms	5	a
	2IN99	Capita selecta systems architecture and networking	5	a
	2IV99	Capita selecta visualization	5	a
	2IM02/1BM02	Internship**	15	a

*) This literature study can only be followed by students that will perform their master project in the Information Systems group of IE&IS.
**) In case the internship is done within the Mathematics and Computer Science department the code is 2IM02. In case the internship is done within the Industrial Engineering & Innovation Sciences department the code is 1BM02. The internship can be followed only by permission of the internship coordinator.

5.3.5 Internship

Since the master project can already be performed in an industrial environment, it is usually advised to spend the rest of the study program on regular courses. In some cases, however, an internship may be a valuable addition to the program, provided that it enhances practical experience, provides deepening of knowledge, and contributes to the specialization. An internship takes 15 credit points as part of the electives, and can be followed only by permission of the internship coordinator. Requests for internships accompanied by convincing arguments explaining the reasons why the intended internship has a clear added value to the study program are to be sent to the internship coordinator dr. J.P. Veltkamp.

5.3.6 Admission to seminars, capita selecta, master project

Capita selecta courses are occasional educational elements, often with a research flavor. They may be experimental courses, a lecture series given by a visitor, or a special individual assignment as a preparation on future research. The capita selecta can be followed only by permission of the responsible lecturer. Students do not have a "right" to do these courses, but they may be granted the possibility.

The seminars, capita selecta, and master project are only open to students that are fully admitted. This means that they are not available for students that do not yet have their BSc diploma or students that did not yet complete the premaster. Other students that have deficiencies (e.g. uncompleted homologation courses) cannot start the master project.

5.4 Approval of study program

The Examinations Committee must approve your program consisting of the mandatory courses and your choice of the electives. In order to obtain this approval you construct

a program, possibly with the help of the study advisor, fill out the program form, have it signed by yourself and the supervisor of your choice and hand it in at the student administration office (MF 3.068).

5.5 Final project

The knowledge and experience, which were acquired in the first part of the program, are applied in an individual setting in order to develop to the necessary level to function as an academic professional in the field of Business Information Systems. The project can be completed in any of the specializations listed in Section 7.1 and Section 7.2, provided that a staff member of the associated group has the supervision.

The start of your master project is marked by submitting a completed graduation plan containing the necessary information on the project (name, place, period, supervisor, and so on), and stating the fact that you have completed your curricular part of the program (see Section 5.4). The form must be accompanied by a project description and signed by you, your supervisor, the head of the relevant specialization and the study advisor. In case the master project is carried out under supervision of a staff member of the Department IE&IS the code is 1BM91.

5.5.1 Admission

During the master project, you should be able to spend full time and concentration on your project. In practice, however, it turns out to be rather difficult to plan curricular activities and, especially, their success. Therefore, we leave room for at most two courses of in total at most ten credit points to be finished during the master project period. Courses that are to be taken as homologation units have to be passed before you can start the master project. Also, be aware that you are not allowed to finish your project before you completed all your courses.

5.5.2 Planning

Together with your supervisor, you decide on a description of your topic and a global planning. You also arrange the supervision method, including how often you and your supervisor will meet to discuss progress. The project is concluded with a thesis and a presentation followed by a defense.

In general, the master project has to be finished within 6 months from the start. An extension to 9 months is possible. In exceptional cases, and only if it is clear that the project can be finished, the exam committee may allow for an additional 3 months period. It is important to note that the project must be finished within 1 year (when working full time) to prevent cancellation of the project, and having to start a new project with a different supervisor. The graduation regulations can be found on the website.

5.5.3 Assessment

Your final project is graded by an assessment committee. The committee usually consists of your supervisor, a staff member from your specialization area, and a staff member from one of the other research groups. The supervisor is responsible for forming this committee at least one month before graduation.

The assessment committee takes the following criteria into account:

Report:	Structure, completeness, correctness, readability, argumentation.
Graduation presentation:	Structure, contents, clarity, contact with audience.
Defense:	Argumentation, demonstration of knowledge, competency in discerning main aspects from details of the project.
Execution of the project:	Level of independence, planning, organization, handling deadlines and setbacks, level of own contribution.

Not all criteria are equally important. The assessment committee decides the relative importance of each criterion to arrive at a final grade. The motivation for the grade is documented in an assessment report.

5.5.4 Checklist

The graduation checklist (Appendix B) summarizes all the steps required from having your study program approved to the graduation ceremony.

5.6 Double degree program BIS and SEC

The qualification to teach computer science to senior secondary pupils is coupled to the 3TU program Science Education and Communication (SEC). This program encompasses 120 credits. In Eindhoven it is offered by the Eindhoven School of Education (ESoE). In the Education track of the SEC program a student specializes in one of four disciplines: maths, physics, chemistry or computer science. Please note that the SEC program is completely lectured in Dutch!

BSc graduates in computer science are directly admitted to the SEC-program. So are MSc graduates from a computer science oriented program like BIS; their SEC-program is reduced to 60 credits because of exemptions. For this last category an even shorter route is available by taking the double degree program, which amounts up to 150 ects. In the BIS-part of the program the stream is replaced by SEC subjects. Enrollment is required for both master programs (one main enrollment and a second enrollment). Certificates will be granted after completion of the whole program.

Details about the curriculum are available at the ESoE website: `http://www.tue.nl/esoe/`.

6 Embedded Systems

The design of innovative software and hardware is the core of technological and industrial progress. Both the departments of Mathematics and Computer Science and Electrical Engineering play an active role in the development of new, innovative technology. The Master of Science program in Embedded Systems at the TU/e is illustrative of this active role, as it is a co-production of these two departments, awaiting students with a background in computer science, as well as graduates from the field of electrical engineering.

The program rests on a sound theoretical foundation, with an emphasis on the design of quality embedded systems. As a graduate of this program, you will have developed a scientific attitude and an engineering approach to the field. Your position will be the design of embedded systems from a high-level architecture viewpoint, via requirements and behavioral specifications and using platforms, hardware and silicon. You will be able to play a leading role in the development of embedded systems, either in scientific research, in industry or governmental organizations.

The Embedded Systems program focuses on the design of efficient and reliable systems. In order to be able to compose dependable protocols for the behavior of such systems, you need knowledge of algorithms, performance, hardware, methods of design and documentation, and an insight into the variability and maintainability of these protocols. All these aspects are addressed in the compulsory part of the program.

The masters degree program in Embedded Systems is a joint program of the 3TU federation. The programs offered at each location shave the common core part (25 credits). Furthermore, some specialisation courses are exchanged by 3TU telefacilities.

6.1 Admission

A Bachelor degree in Computer Science or in Electrical Engineering obtained at a Dutch university provides direct admission to the ES program. Students with a different degree and from foreign universities have to apply for admission via the admission committee. Dutch HBO graduates have to take a pre-master program before they can be admitted, see Section 2.4.

The admission procedure is described in Section 1.5, and the requirements are listed in the Teaching and Examination Regulations (see Appendix A.3).

6.2 Goals

At the end of the academic studies, in addition to the qualities mentioned in article 1.3 of the Education and Examination Regulations (see Appendix A.3), the master student will have developed the following domain specific competences:

- The graduate has a holistic view on systems and system development. On the one hand he is capable of an abstract view to understand and master systems of huge complexity. On the other hand he is able to describe and study the structure and the behavior of the (embedded) systems in precise detail. He understands the position and importance of the system during its lifetime.
- The graduate has thorough knowledge of contemporary techniques to realize embedded systems. He has sufficient academic background to understand and apply techniques that will become available within the next decades. He is cost and environment aware, thus capable of making optimal use of available means (software/hardware).
- The graduate has a sufficient basis to design embedded systems at the required level of quality, or assess a priori that such a design cannot be constructed. This presupposes thorough knowledge of requirement engineering, modeling, testing and implementation techniques.
- The graduate has a flexible and inquisitive mind. He understands the theories, techniques and tools in this field in such a way that he is able to adapt these to optimally fit their purpose. He is able to invent his own tools, theories and techniques if these are not available.

6.3 Curriculum

The curriculum consists of computer science courses and courses in electrical engineering. This section describes the curriculum at the TU/e; the programs of the two partner universities can be found in the Teaching and Examination Regulations (see Appendix A.3).

6.3.1 Core program

The core program is mandatory for all students.

Quarter	Code	Unit	ECTS	Exam
1	2IN26*	Real-time Systems	5	w+a
1-2	5KK73*	Embedded Computer Architecture	5	a+o
2	2II45	Architecture of distributed systems	5	w+a
2	2IW15	Automated reasoning	5	w+a
2	2IN27*	Quantitative Evaluation of Embedded Systems	5	w+a
3	2IW26*	System Validation	5	w+a
3-4	5KK03*	Embedded Systems Laboratory	5	a+o
3-4	5KK60	Systems on silicon	5	w+a
3-4	5KK80	Multiprocessors	5	a+o
	2IM92/5T514	**Preparation graduation project ES****	10	a

$*$) These courses are in the common core of the 3TU program.
$**$) Preparation for graduation project ES consists of a literature survey and feasibility study for the graduation project. The preparation has to be finished and graded before the start of the final project.

Students who have completed a bachelor program in *computer science* are required to include some additional units as homologation study components in the elective part of the master program:

Quarter	Code	Unit	ECTS	Exam
1	5DD17	Circuit analysis	3	w
1-2	5HH30	Digital signal processing	3	w
2	5HH00	Electronics for embedded systems	3	w

Students who have completed a bachelor program in *electrical engineering* are required to include some additional units as homologation study components in the elective part of the master program:

Quarter	Code	Unit	ECTS	Exam
1	2IL65	Algorithms	3	w+a
1-2	2IW05	Software specification	6	w+a
2	5HH00	Electronics for embedded systems	3	w

6.3.2 Electives

The elective part of the curriculum consists mainly of courses. In general, courses can be chosen freely from the list provided this section.

Some courses may be prescribed as homologation courses (up to 18 credits) to make up for deficiencies in former education, as mentioned in Section 6.3.1. Other courses may only be selected after approval by the Examinations Committee in advance (please consult the master study advisor). In some cases an internship of 15 credits may be part of the electives, see Section 6.3.3.

Quarter	Code	Unit	ECTS	Exam
1	2IC35	Physical aspects of digital security	5	w
1	2ID25	Information retrieval	5	w+a
1	2ID55	Adaptive systems	5	a
1	2II65	Metamodeling and interoperability	5	w+a
1	2IL45	Advanced algorithms	5	a
1	2IN28	Grid and cloud computing	5	a
1	2IS15	Generic language technology	5	w+a
1	2IV35	Visualization	5	a
1	2IW55	Algorithms for model checking	5	w+a
1	5DD50	Advanced topics in multimedia coding	4	a+o
1	5L130	Electrophysiology	3	o
1	5ME00	Signal processing for communication	3	w
1	5ME10	Statistical signal processing	3	w
1	5ME20	Ubiquitous computing and activity recognition	5	a
1	5MX00	Dynamical systems	3	w
1	5N280	Low-power electronics	4	o
1	5P340	Information theory 2	4	o
1	5P450	Analogue/digital and digital/analogue converters	4	o
1	5P530	Video processing for multimedia systems	4	o
1	5P690	Advanced actuator systems	4	w
1-2	9ST14	Academic skills in English 1[1]	4	w+o
2	2IF85	Program verification techniques	5	w+a
2	2II35	Web information systems	5	w+a
2	2II70	Constraint programming	5	a
2	2IL55	Geometric algorithms	5	a
2	2IS25	Distributed trust management	5	w+a
2	2IS26	Model-based software and systems engineering	5	w+a
2	2IV55	Interactive virtual environments	5	a
2	2IW01	Embedded computer architecture 2[2]	5	w+a
2	5MB30	Robust control	3	w
2	5MC10	Combinatorial algorithms	3	w
2	5MD00	Computer architecture	3	a+o
2	5MF00	EM waves and antennas	2	w

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Quarter	Code	Unit	ECTS	Exam
2	5MG00	Mathematics for electromagnetism	3	a
2	5MH00	Computational electromagnetics	3	a
2	5MY10	Wireless communication I	3	w
2	5P500	Monitoring of respiration and circulation	3	w
2	5SC20	State space control	3	w
3	2ID45	Advanced databases	5	w+a
3	2IF65	Proving with computer assistance	5	w+a
3	2II55	Business process management systems	5	w+a
3	2IL75	Algorithms for massive data	5	a
3	2IS55	Software evolution	5	a
3	2IV05	Additional component computer graphics	5	a
3	5KK06	Computer arithmetic[2]	5	w+a
3	2IW04	Knowledge based control systems[2]	4	w+a
3	5DD40	Multimedia video coding and architecture	4	a+o
3	5MB10	Model reduction	3	w
3	5MB20	Adaptive information processing	3	w
3	5MB40	System identification	3	w+a
3	5MD20	Design automation	3	w
3	5MH20	EM theory of wave guides	3	a+o
3	5MH30	Optical communication technology	3	a
3	5P060	Nonlinear systems / neural networks	4	w
3	5P670	Advanced topics in multi-service data networks I	2	o
3	5SC21	Modeling and predictive control	3	a+o
3	5TT40	RF transceiver electronics	3	a
3-4	2IF02	Verification of security protocols	6	w+a
3-4	5P220	Antennas and propagation	4	o
3-4	5P480	Knowledge systems and applications	4	a+o
3-4	5TT30	Photonic IC design	3	a
3-4	5TT50	Advanced CMOS design	4	a
3-4	9ST14	Academic skills in English 1[1]	4	w+o
4	2ID35	Database technology	5	w+a
4	2IF45	Process algebra	5	w+a
4	2II75	Business process simulation	5	a
4	2IN35	VLSI programming	5	a
4	2IP45	Software project management	5	a
4	2IV15	Simulation in computer graphics	5	a
4	2IW02	Real-time software development[2]	5	a
4	2IW45	Programming by calculation	5	a
4	5N520	Statistical bioinformatics	2	o
4	5P630	Special topics in power electronics	4	a
4	5P680	Advanced topics in multi-service data networks II	2	o
4	5TT00	Optical communication networks	3	w+a
	5P050	Selected topics in Electronics	4	o

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Quarter	Code	Unit	ECTS	Exam
		Seminars		
1	2IF96	Seminar formal system analysis	5	a
2	2ID95	Seminar databases and hypermedia	5	a
2	2II96	Seminar architecture of information systems	5	a
2	2IL95	Seminar algorithms	5	a
2	2IN95	Seminar systems architecture and networking	5	a
2	2IS95	Seminar software engineering and technology	5	a
2	2IV95	Seminar visualization	5	a
3-4	2IF02	Seminar information security technology	6	a
4	2IF96	Seminar formal system analysis	5	a
4	2IL95	Seminar algorithms	5	a
		Capita Selecta		
	2IC99	Capita selecta security	5	a
	2ID99	Capita selecta databases and hypermedia	5	a
	2IF98	Capita selecta formal system analysis	5	a
	2II99	Capita selecta architecture of information systems	5	a
	2IL99	Capita selecta algorithms	5	a
	2IN99	Capita selecta systems architecture and networking	5	a
	2IS99	Capita selecta software engineering and technology	5	a
	2IV99	Capita selecta visualization	5	a
		Internship / Multi-disciplinary design project (second year)		
	2IM02/5L990	Internship[3]	15	a
	2IW70/5KK05	Multi-disciplinary design project[3]	10	a

[1] For foreign students, and for students who have completed a polytechnic (HBO) programme of computer science.
[2] Offered as a tele-lecture.
[3] Note that only one of these may be chosen, and that the Internship requires permission of the coordinator. See Section 6.3.3 for the details.

6.3.3 Internship or multi-disciplinary design project

Since the master project can already be performed in an industrial environment, it is usually advised to spend the rest of the study program on regular courses. In some cases, however, an internship (code 2IM02 or 5L990) may be a valuable addition to the program, provided that it enhances practical experience, provides deepening of knowledge, and contributes to the specialization. An internship takes 15 credit points as part of the electives, and can be followed only by permission of the internship coordinator. Requests for internships accompanied by convincing arguments explaining the reasons why the intended internship has a clear added value to the study program are to be sent to the internship coordinator dr. J.P. Veltkamp. Instead of an internship, a multi-disciplinary design project (code 2IW70 or 5KK05) can be performed, in which students work in groups of 2 to 3 on an embedded design under the supervision of a member of

staff. We refer to the course page for more information. Note that it is not possible to do both an internship and the multi-disciplinary design project.

6.3.4 Admission to seminars, capita selecta, master project

Capita selecta courses are occasional educational elements, often with a research flavor. They may be experimental courses, a lecture series given by a visitor, or a special individual assignment as a preparation on future research. The capita selecta can be followed only by permission of the responsible lecturer. Students do not have a "right" to do these courses, but they may be granted the possibility.

The seminars, capita selecta, and master project are only open to students that are fully admitted. This means that they are not available for students that do not yet have their BSc diploma or students that did not yet complete the premaster. Other students that have deficiencies (e.g. uncompleted homologation courses) cannot start the master project.

6.4 Approval of study program

The Examinations Committee must approve your program consisting of the mandatory courses and your choice of the electives. In order to obtain this approval you construct a program, possibly with the help of the study advisor, fill out the program form, have it signed by yourself and the supervisor of your choice and hand it in at the student administration office (MF 3.068).

6.5 Final project

The project can be completed in any of the specializations listed in Section 7.1 and Section 7.3, provided that a staff member of the associated group has the supervision. In case the project is carried out under supervision of a staff member of the Mathematics and Computer Science department, the course code is 2IM91. In case the supervisor is from the Electrical Engineering department, the code is 5T746.

The start of your master project is marked by submitting a completed graduation plan containing the necessary information on the project (name, place, period, supervisor, and so on), and stating the fact that you have completed your curricular part of the program (see Section 6.4). The form must be accompanied by a project description and signed by you, your supervisor, the head of the relevant specialization and the study advisor.

6.5.1 Admission

During the master project, you should be able to spend full time and concentration on your project. In practice, however, it turns out to be rather difficult to plan curricular activities and, especially, their success. Therefore, we leave room for at most two courses of in total at most ten credit points to be finished during the master project period. Courses that are to be taken as homologation units have to be passed before you can start the master project. Also, be aware that you are not allowed to finish your project before you completed all your courses. Note that the *preparation for graduation ES project* (2IM92 or 5T514) needs to be finished and graded before you can start the master project.

6.5.2 Planning

Together with your supervisor, you decide on a description of your topic and a global planning. You also arrange the supervision method, including how often you and your supervisor will meet to discuss progress. The project is concluded with a thesis and a presentation followed by a defense.

In general, the master project has to be finished within 6 months from the start. An extension to 9 months is possible. In exceptional cases, and only if it is clear that the project can be finished, the exam committee may allow for an additional 3 months period. It is important to note that the project must be finished within 1 year (when working full time) to prevent cancellation of the project, and having to start a new project with a different supervisor. The graduation regulations can be found on the website.

6.5.3 Assessment

Your final project is graded by an assessment committee. The committee consists of three voting members, including your supervisor. The voting members are from at least two research groups within the Computer Science division and the Electrical Engineering department at the TU/e or within the corresponding departments at the TUD or UT. The supervisor is responsible for forming this committee at least one month before graduation.

The assessment committee takes the following criteria into account:

Report:	Structure, completeness, correctness, readability, argumentation.
Graduation presentation:	Structure, contents, clarity, contact with audience.
Defense:	Argumentation, demonstration of knowledge, competency in discerning main aspects from details of the project.
Execution of the project:	Level of independence, planning, organization, handling deadlines and setbacks, level of own contribution.

Not all criteria are equally important. The assessment committee decides the relative importance of each criterion to arrive at a final grade. The motivation for the grade is documented in an assessment report.

6.5.4 Checklist

The graduation checklist (Appendix B) summarizes all the steps required from having your study program approved to the graduation ceremony.

7 Specializations

In this chapter, you can read about the different specialization options for the master programs. For every specialization the field of interest is indicated and courses are mentioned that contain relevant material for students that wish to participate in the research in that area. The courses are not meant to be obligatory for candidate graduates, but they give an impression of the predispositions of the staff. The contact person mentioned may give you additional information on the possibilities of a graduation project in that specialization.

7.1 Specializations for CSE, BIS, ES, and IST

This section describes specializations that are relevant for all master programs. The specializations correspond to the eight research groups in de Computer Science division.

7.1.1 Algorithms

Contact person: prof. Mark de Berg

The creation, storage, analysis and manipulation of spatial data plays a central role in robotics, computer graphics, geographical information systems, and other areas of computer science. In all these areas, there are many challenging algorithmic questions. For example, a typical problem in robotics is to compute efficient routes for a robot moving through a factory building while avoiding all obstacles in its way. A typical problem in geographic information systems could be to find a good location of a new airfield, say the location such that the region in a 20-mile radius around it is the least populated. Such problems form the focus of this specialization: we study techniques and concepts for the design and analysis of efficient algorithms and data structures, with

emphasis on algorithms for spatial data. Typical master projects are either experimental or theoretical in nature, depending on the interests of the student.

Relevant courses for the ALG specialization are:

- Algorithms for massive data (2IL75)
- Advanced algorithms (2IL45)
- Geometric algorithms (2IL55)
- Seminar algorithms (2IL95)
- Capita selecta algorithms (2IL99)

Other relevant courses:

- Additional component computer graphics (2IV05)
- Visualization (2IV35)
- Interactive virtual environments (2IV55)

7.1.2 Architecture of Information Systems

Contact person: dr. Natalia Sidorova

The Architecture of Information Systems (AIS) research group investigates methods, techniques and tools for the design and analysis of Process-Aware Information Systems (PAIS), i.e., systems that support business processes (workflows) inside and between organizations. AIS is not only interested in these information systems and their architecture, but also model and analyze the business processes and organizations they support. The group aims at results that are highly original and applicable in real-life situations. The main three research lines of AIS are:

- Process Modeling and Analysis. Models are commonly used to answer questions related to correctness and performance. One of the main goals here is to further improve verification techniques to check various properties such as soundness, data/resource soundness, accordance, controllability, and selected temporal properties. Pattern-based approaches are used for correctness-by-design. Another goal is to develop innovative simulation approaches that better reflect reality and that can be used in an operational setting while using process mining results.
- Process Mining. Process mining techniques are used to extract process-related information from event logs, e.g., to automatically discover models, check conformance, and augment existing models with additional insights extracted from some event log. The goals are to significantly improve the state-of-the-art in process discovery, to advance the state-of-the-art in conformance checking, and to predict problems, i.e., provide warnings based on historic information (e.g., a case will be late or an error is likely to occur).

- PAIS Technology. PAISs are used to manage and execute operational processes involving people, applications, and/or information sources. Examples are WFM (Workflow Management), BPM (Business Process Management), and ERP (Enterprise Resource Planning) systems. Increasingly, these systems are driven by models and produce high-quality event logs. We are interested in the artifacts used and produced by these systems (i.e., models and logs) as these are essential for testing the techniques developed in the two other research lines. For example, it is interesting to convert and verify process models expressed in some particular industry language. The same holds of course for event logs. Service-orientation plays an important role here and this new architectural style poses new research questions.

Relevant courses for the AIS area of expertise are:

- IT-governance (1BM65)
- Information retrieval (2ID25)
- Architecture of distributed systems (2II45)
- Business process management systems (2II55)
- Metamodeling and interoperability (2II65)
- Contraint programming (2II70)
- Business process simulation (2II75)
- Seminar architecture of information systems (2II96)
- Capita selecta architecture of information systems (2II99)

7.1.3 Databases and Hypermedia

Contact person: dr. Toon Calders

The focus of DH is on the study of concepts and technologies that are used to store, access and manage information. Information often comes from several sources that each contains a wealth of information of which only a small subset is of interest to any particular user or user group.

- Database systems are needed to store, maintain, and efficiently query the data; data can come in different flavors from unstructured text-data, semi-structured XML data to structured databases;
- Datamining and information retrieval automate the extraction of information and knowledge from large amounts of data; often so much data is collected that manual analysis is no longer possible. Data mining and information retrieval assist data analysts in locating relevant information and patterns in the data.
- Web-information systems make these databases accessible over the Web; and

- Adaptation, or automatic personalization, must ensure that each user is guided (automatically) to the information that is relevant to him or her, resulting in Adaptive Hypermedia systems. Adaptive Hypermedia is studied at the conceptual and the practical level: the former is done through the study of Adaptive Hypermedia Reference Models, the latter through the development of the Adaptive Hypermedia Architecture (currently named AHA!), a general-purpose web-based adaptive hypermedia system.

The DH group focuses research in these overlapping domains aimed at the efficient disclosure of large data repositories in a user-friendly manner.

Relevant courses for the DH area of expertise are:

- Advanced databases (2ID45)
- Information retrieval (2ID25)
- Database technology (2ID35)
- Adaptive systems (2ID55)
- Capita selecta databases and hypermedia (2ID99)
- Web information systems (2II35)
- Seminar databases and hypermedia (2ID95)

7.1.4 Formal System Analysis

Contact person: prof. Jan Friso Groote

The focus of the specialization FSA is on modeling and verifying behavior of systems and programs. Behavior must be understood as all possible actions that a system can consecutively perform during its lifetime.

Computer-based systems are so complex, that it is impossible to program them without understanding how the different software components communicate, and what the responsibilities of these parts are. By modeling the behavior, these responsibilities are made explicit. Due to the complexity of the matter at hand, it is also non-trivial to get these behavioral models correct. For this purpose we use analysis techniques. Primarily, these are used to find flaws in the model, and ultimately these are employed to show that the modeled behavior satisfies all the requirements. For instance, a data communication protocol must not lose messages, and a firewall should under no circumstance let an intruder pass. With current modeling techniques it is no problem to model the communication patterns of even the most complex systems. Using modal formulas most requirements can be formulated in a formal, precise way. Using one of the many existing process equivalences, it is very well possible to state the behavioral equivalence between implementations and specifications. So, in general, it is not really problematic (but sometimes hard) to formulate the properties that a system ought to have.

The current technological bottleneck is our capability to prove that a requirement holds for a given model (the model checking problem) or that two processes are actually equivalent (the equivalence checking problem). The major research activity of this group is to increase the strength of the analysis tools. The core problem of the analysis of behavior is the state space explosion problem. There are so many states in which a system can end up, that it is generally impossible to explore these all individually. For this purpose, we must use so-called symbolic techniques to enable the verification. These techniques come from the realm of automatic reasoning, term rewriting and computer assisted theorem checking. Also, state space reduction techniques (abstract interpretation, confluence checking) are relevant to reduce the problem size. Visualization turns out to be a relevant tool, to detect unforeseen problems and to increase insight in the behavior. Knowledge of algorithms, including I/O-efficient algorithms is relevant, to construct analysis tools capable of dealing with huge state spaces.

In order to investigate how effective our analysis techniques are, we are constantly assessing their practical use. For instance, the FSA group is involved in the standardization of several protocol standards (e.g. firewire). Our role is to assist the standardization process by showing where the protocol does not conform to its intention. With several of the embedded system industries around Eindhoven, we have a similar relationship: we design, model and analyze (parts of) the behavior of the equipment they are building.

Relevant courses for the FSA specialization are:

- Automated reasoning (2IW15)
- System validation (2IW26)
- Programming by calculation (2IW45)
- Algorithms for model checking (2IW55)
- Seminar formal system analysis (2IW96)
- Capita selecta formal system analysis (2IW98)
- Program verification techniques (2IF85)
- Formal modelling in cell biology (2IF35)
- Process algebra (2IF45)
- Proving with computer assistance (2IF65)
- Architecture of distributed systems (2II45)
- Advanced algorithms (2IL45)
- Generic language technology (2IS15)
- Visualization (2IV35)

7.1.5 System Architecture and Networks

Contact person: dr. Rudolf Mak

Imagine just any electronic system that is not somehow networked with other systems. Found one? Must be a pretty boring system then, since one of the fascinating developments of the last years is that devices of all form factors and functionality become connected. In our group we study parallel and distributed systems with an emphasis on pervasive systems or, as we call it, Resource Constrained Networked Embedded Systems.

Relevant courses for the SAN specialization are:

- Real-time systems (2IN26)
- Architecture of distributed systems (2II45)
- VLSI programming (2IN35)
- Seminar systems architecture and networking (2IN95)
- Capita selecta systems architecture and networking (2IN99) (not always given)

Other relevant courses are:

- Quantitative Evaluation of Embedded Systems (2IN27)
- Adaptive systems (2ID55)
- Seminar security technology (2IC95)
- Distributed trust management (2IS25)
- Web information systems (2II35)
- Advanced algorithms (2IL45)
- Generic language technology (2IS15)
- System validation (2IW26)

Master thesis assignments are related to the research topics of SAN, which focus on distributed aspects of RCNES (middleware and networked services), on the platform (predictable and reliable resource management) and on efficient embedded computations (typical for signal processing). Research questions are, for example, how to build and manage applications composed from distributed services, and how to perform distributed resource management.

We pay a lot of attention to quality aspects, which include performance, predictability, dependability, programmability and security. A dominant issue in our work is therefore the architecture of these RCNES, in particular the software architecture, as this is where the quality aspects are addressed. We relate our work to application domains which we see as vehicles for our research. Example application domains include distributed media systems, wireless sensor networks, automotive electronics and, more recently, lighting. Much of this work is done in cooperation with industry through national and international projects. Have a look at our research page to see the projects we are involved in: http://w3.win.tue.nl/nl/onderzoek/onderzoek_informatica/system_architecture_and_networking.

7.1.6 Software Engineering and Technology

Contact person: prof. Mark van den Brand

The software industry is facing two trends. First of all, the amount of software is exploding. Secondly, the quality of software is decreasing. These trends result in new research challenges. How to develop more high quality software in less time? How to guarantee the quality of the software? How to deal with the huge amount of existing software? The answers to these questions are not straightforward. A common theme in the answer to these questions is model driven software engineering. Models provide a higher level of abstraction and thus allow the specification of more functionality in less code. The models can also be used as starting point for simulation and verification. Finally, existing software can be analyzed and the underlying models can be extracted. The research focus of the research group SET is on model driven software development. The field of model driven software development is broad. In fact we specialize in two directions: the development of tooling to support the development of models in domain specific formalisms and the extraction of high level models given source code. Research on tooling for model driven software development includes the development of semantics of domain specific languages, semantics of model transformation formalisms, quality of model transformations and model versioning. The ultimate goal is to provide a tool set which provides high fidelity software generation.

The other side of the coin is the extraction of information from existing source code. Again this is a broad field. The success of research in this field depends on the flexibility of the tooling. The analysis of software should not be restricted to one programming language, but should be multi-lingual. Our expertise in generic language technology is crucial to be able to deal with multi-lingual software systems. In close cooperation with LaQuSo multi-lingual tooling for software analysis and visualization has been developed. The ultimate goal of this research is to extract models of existing source code at the right level of abstraction. These models can then be used for maintenance purposes, verification, and/or forward engineering.

A third research topic is the development of an integrated development environment to allow the development of software and proofs at the same time. The challenges in this type of research are flexibility and scalability. An environment which is too slow or tedious to use will never become a success. Our focus is to develop an environment where the software developer is supported by a collection of provers when developing the software. This research is closer to programming-in-the-small and is strongly related to the Eindhovens way of software development, once promoted by E.W. Dijkstra.

Relevant courses for the SET specialization are:

- Generic language technology (2IS15)
- Software evolution (2IS55)
- Architecture of distributed systems (2II45)
- Programming by calculation (2IW45)

- Seminar Software Engineering and Technology (2IS95)
- Process algebra (2IF45)
- Program verification techniques (2IF85)

7.1.7 Visualization

Contact person: dr. Huub van de Wetering, dr. Michel Westenberg

The focus of this specialization is on the development of new methods and techniques for interactive visualization in order to analyze and understand large datasets. The main fields of interest are information visualization and visual analytics, both aiming at insight in abstract data, such as tree structures, networks, and multivariate data, for applications in areas as software engineering, biological networks, and areas such as moving object analysis. Our aims are to develop new visual representations and interaction methods, as well as new evaluation methods to obtain a better understanding of the visualization process itself. Another interest is in high performance scientific computing, applied to visualization and computer graphics.

Furthermore, in cooperation with the National Research Institute for Mathematics and Computer Science (CWI) desktop virtual reality systems are studied. Typical topics here are to develop methods for calibration, input - including 2D/3D combination input - and pattern matching and to build and evaluate applications.

Relevant courses for the VIS specialization are:

- Visualization (2IV35)
- Geometric algorithms (2IL55)
- Additional component computer graphics (2IV05)
- Simulation in computer graphics (2IV15)
- Interactive virtual environments (2IV55)
- Seminar visualization (2IV95)
- Capita selecta visualization (2IV99)

Other relevant courses:

- Information Retrieval (2ID25)

7.1.8 Security

Contact person: prof. Sandro Etalle

The interconnectivity and pervasiveness of computers and of embedded systems like PDAs and smart phones is not only determining new functionalities, but is also opening the way to increasingly sophisticated attacks. Indeed, in the last years the field of security has become one of the main focuses of computer science research around the globe.

The recently established security group aims at contributing to a comprehensive framework for the engineering, the deployment and the maintenance of secure distributed systems, in which existing and new techniques are harmonized and integrated. The group focuses on distributed system security: a broad area that deals with the security of embedded systems as well as of the ICT infrastructures. Prominent subfields are: the specification and the enforcement of usage policies of critical systems, verification of security protocols, trust management.

The group cooperates actively with the Radboud University Nijmegen and the University of Twente in the Kerckhoffs security master.

Relevant courses for the SEC specialization are:

- Seminar information security technology (2IF03)
- Verification of security protocols (2IF02)
- Distributed trust management (2IS25)
- Hackers hut (2IF17)
- Cryptography 1 (2WC12)
- Cryptography 2 (2WC13)
- Coding and crypto 1 (2WC09)
- Physical aspects of computer security (2IC35)
- Software evolution (2IS55)

7.2 Additional specializations for BIS

Students in the BIS program can specialize in any of the Computer Science research groups mentioned in Section 7.1. In addition, specialization is possible in two research groups in the IE&IS department.

7.2.1 Information Systems (IE&IS-IS)

Contact person: dr.ir. Jos Trienekens

The specializations of the Information Systems group are as follows:

- Architecture/EIS. The cluster addresses research topics that deal with design of enterprise information systems at a high level of abstraction.
- Business Process Management. The research is conducted against the insight that operational performance is most effectively managed in many domains by a focus on cross-functional business processes and the application of information technology.
- Cross-Organizational Information Systems. Within the cluster a number of topics related to cross-organizational information systems is being investigated.

- Process Mining. Research is concerned with the extraction of knowledge about a (business) process from its process execution logs. Process Mining strives to gain insight into various perspectives, such as the process (or control flow) perspective, the performance, data, and organizational perspective.
- Software Management. The Software Management cluster focuses on topics related to the development and implementation of (embedded) software and information systems.
- Healthcare. The focus of the Healthcare cluster is on the application of information systems in the healthcare domain, in particular to improve the safety, effectiveness, and efficiency of operational processes within and across hospitals, health and treatment centers, private clinics, and other medical institutes.

For more information see http://w3.ieis.tue.nl/en/groups/is/

7.2.2 Operations, Planning, Accounting, and Control (IE&IS-OPAC)

Contact person: dr.ir. Henny van Ooijen

The sub-department Operations, Planning, Accounting, and Control performs research into the control of operational processes in service and manufacturing industries. Operational processes can be manufacturing processes of all kinds, distribution processes, transportation processes, warehouse processes, retail processes, but also service processes like maintenance of equipment, health care processes and public transportation.

There are four research programs within OPAC:

- Capital Goods
- Physical Distribution and Logistics Management
- Process Industry Operations
- Healthcare Operations

For more information see http://w3.ieis.tue.nl/en/groups/opac/ or contact h.p.g.v.ooijen@tue.nl.

7.3 Additional specializations for ES

Students in the ES program can specialize in any of the Computer Science research groups mentioned in Section 7.1. In addition, specialization is possible in the EE department.

7.3.1 Electronic systems

Contact person: ms. Marja de Mol

The mission of the section electronic systems is to provide a scientific basis for design trajectories of digital electronic circuits and systems "from (generalized) algorithm to realization". To identify the key problems, and verify the validity, robustness and completeness of our results, we develop, implement and maintain consistent and complete flows, and use them for realizing innovative multimedia hardware with emphasis on video processing and embedded architectures.

The research focuses on how to convert the "art" of designing electronic systems into methodology, an absolute necessity, because

- the complexity of modern integrated circuits continues to increase,
- new physical phenomena at submicron feature dimensions are having more and more impact, not only on performance, but even on the functionality,
- and the heavy demand pull from signal processing applications, in particular multimedia and telecommunications, requires rigorous and robust answers.

The approach taken is an algorithmic one, based on combinatorics and process algebra. The main application area is video processing. More information can be found on `http://www.es.ele.tue.nl`.

Core courses for the Electronic Systems specialization are:

- Combinatorial algorithms (5MC10)
- Computer architecture (5MD00)
- Design automation (5MD20)
- Signal processing for communication (5ME00)
- Video processing for multimedia systems (5P530)
- Advanced topics in multi-service data networks I (5P670)
- Advanced topics in multi-service data networks II (5P680)

8 EIT Tracks

EIT ICT Labs Master School offers an international Master program on *ICT Innovation*, combining and integrating technical majors with a fully standardized minor on Innovation and Entrepreneurship. As a student in the EIT ICT Labs Master School you not only get fundamental knowledge and skills on a technical topic, but also learn how to drive your innovative ideas to the market.

Mobility

A distinctive feature of the ICT Innovation program is geographic mobility: you will study at two top-notch universities in two different European countries. When you apply for admission to the two-year program, you select an entry point (the university at which you do the first year of the program), and an exit point (the university at which you do the second year of the program). You will also travel to a kick-off event, summer and winter schools to meet other students, business partners and professionals. Learning about cultural and language differences enables our students to become experts in their technical field and also succeed as managers in global markets.

Double Degrees and the EIT ICT Labs certificate

When you successfully complete the program you will receive a double degree from your entry point university and your exit point university. In addition, you will get the EIT ICT Labs certificate, documenting the EIT ICT Labs specific learning outcomes on Innovation and Entrepreneurship.

Tuition fee waivers

For the top 30% of the admitted students, EIT ICT Labs will provide tuition fee waivers. Furthermore, EIT ICT Labs is trying to secure funds with the European Commission to also offer scholarships covering personal expenses.

Two tracks

Eindhoven University of Technology offers two tracks in the context of the ICT Innovation program:

Embedded Systems: This program equips engineers of tomorrow to specify, design, and implement computer systems that are widely used in a variety of personal and industrial devices in e.g. transportation and health-care.

Service Design and Engineering: This program will provide both the technical competence and the entrepreneurial and innovative skills needed for a successful business in the area of service design and engineering.

8.1 Service Design and Engineering

The Master program on Service Design and Engineering (SDE) is a two-year Master program organized in the context of the EIT ICT Labs Master School. It provides both the technical competence for the design and engineering of services and skills in the area of entrepreneurship and innovation.

The first year is common for all SDE students and consists of technical courses in areas important for SDE (e.g., information systems, distributed systems, business process management and software engineering). It also includes an extensive module on entrepreneurship and innovation.

For the second year, you choose one of the following specializations: Mobile Services, Service-oriented Business Process Management, Service-oriented Social Informatics, and Distributed Service Systems.

A distinctive feature of the program is that you study at two universities in two different countries. For the first year you have to choose between Aalto University (Finland) or Eindhoven University of Technology (The Netherlands). The university at which you do the second-year specialization, depends on the specialization of your choice:

- The specialization on Mobile Services is offered by Aalto University.
- The specialization on Service-oriented Business Process Management is offered by Eindhoven University of Technology.
- The specialization on Service-oriented Social Informatics is offered by University of Trento.

- The specialization on Distributed Service Systems is offered by a collaboration of two universities in Budapest.

The university at which you do the first year of the program is called the entry point; the university at which you do the second year specialization is called the exit point.

For details about the other specializations we refer to the website of the EIT ICT Labs Master School: http://eitictlabs.masterschool.eu/.

8.1.1 Goals

The general learning outcomes of the programme are:

- Identify and master appropriate software technologies, architectures and systems related to service-oriented computing.
- Relate business insights and behavioral, legal, and societal expertise in modern information systems and services.
- Analyze the user and organizational needs for services and their decomposition.
- Analyze different service-oriented computing approaches and open standards.
- Relate technology skills (e.g. communication, knowledge integration, engineering systems) with strategic business expertise in practicable technology and business opportunities.
- Model, design and integrate software intensive service applications and information systems considering various stakeholder requirements, their potential evolution as well as scalability, usability and security dimensions.
- Communicate complex and intangible challenges and solutions in an explicit and concrete manner with diverse professional experts.
- Co-operate in international and multidisciplinary teams and apply expertise from diverse competence domains and cultures to construct and develop concrete solutions.
- Apply state-of-the-art theories in service science in real enterprise experiences.
- Propose novel and innovative services with sustainable business models.

8.1.2 Entry point program

Aalto and TU/e will offer an entry-point programme for the SDE technical major. It consists of a *Technical Common Base* of 20-25 ECTS, an *(entry point) I&E module* of 20 ECTS, and *Electives* (15-20 ECTS).

The following table summarises the TU/e entry-point programme as it will run in the academic year 2012-2013:

Quarter	Code	Unit	ECTS
1	2ID25	Information retrieval	5
1	1ZS01	Technology entrepeneurship	3
2	2II45	Architecture of distributed systems	5
2	1ZS02	Technology entrepeneurship: business plan development	3
1-2		**Electives and homologation**	15
3	2II55	Business process management systems	5
3	1ZS20	Corporate entrepeneurship	3
3-4	1ZM55	Service engineering and marketing	5
3-4		**Winter school and extended project in 1ZM55**	2
4	2IP45	Software project management	5
4		**Electives**	5
		Summer school*	4

*) The Summer School of 4 ECTS, which is counted as part of the entry-point programme will be organised centrally by the ESML.

Electives and homologation

To complete their entry-point programme at TU/e, students may elect courses from the following list. On an individual basis, we will recommend electives based on the choice of specialisation by the student.

We shall require all SDE students to take the BSc course Business Information Systems (2II07) in the first semester to prepare for the course 2II55 Business Process Management Systems.

Quarter	Code	Unit	ECTS
1	2IL45	Advanced algorithms	5
1	2IN26	Real-time systems	5
1	2IS15	Generic language technology	5
1	2IC35	Physical aspects of digital security	5
1	2IN28	Grid and cloud computing	5
2	2II70	Constraint programming	5
2	2II35	Web information systems	5
2	2IS25	Distributed trust management	5
2	2II95	Seminar architecture of information systems	5
2	2IN95	Seminar system architecture and networking	5
2	2IS95	Seminar software engineering and technology	5
3	2IW26	System validation	5
3-4	2IF02	Verification of security protocols	6
3-4	2IF03	Seminar information security technology	6
4	2IF96	Seminar formal system analysis	5
4	2II75	Business process simulation	5
4	2ID35	Database technology	5
4	2IF45	Process algebra	5

8.1.3 Exit point program

All SDE consortium partners will offer an exit-point programme. It will have the following constituents: 3 to 4 technical courses related to the specialisation at the exit point (20 ECTS), an I&E course, laboratory or project (4 ECTS), an I&E thesis (6 ECTS), and a masters thesis project (30 ECTS). The I&E thesis can be either a extra chapter in the masters thesis discussing the business aspects of the master thesis project, or a separate academic I&E paper.

Starting in 2013-2014, TU/e will offer an exit-point programme with a specialisation in the direction of Service-oriented Business Process Management. The specialisation will be organised by the Architecture of Information Systems group.

The following table summarises the programme:

Quarter	Code	Unit	ECTS
1	2II65	Metamodeling and interoperability	5
1	1BM45	Data mining and process mining	5
1-2	1BM10	Electronic business architectures and systems	5
2	2II95	Seminar architecture of information systems	5
2		**Elective**	4
3-4		**I&E minor thesis**	6
3-4		**Master's thesis project**	30

Master's thesis project

The Masters Thesis project will be carried out within one of the EIT ICT Labs business partners Philips and Novay. TU/e participates, together with Philips, in a research-to-business project Service Spaces for Health and Wellbeing. Together with Philips we will define graduation projects associated with that project. Note that the role of service spaces for health and wellbeing will also be addressed in the course 2II65 Metamodeling and Interoperability.

Exit-point I&E module

The exit-point programme contributes 11 ECTS to the I&E module through the course 1BM10 Electronic Business Architectures and Systems and through the I&E Minor Thesis. The latter is planned to be a chapter in the Masters Thesis elaborating in detail on a business plan pertaining to the technical subject of the thesis.

Electives

The following courses are suitable as electives:

Quarter	Code	Unit	ECTS
2	2II35	Web information systems	5
2	2II70	Constraint programming	5
2	2IS25	Distributed trust management	5

8.2 Embedded Systems

The term embedded system refers to electronic components (which almost invariably include one or more software programmable parts) of a wide variety of personal and industrial devices, e.g., transportation systems, health-care equipments as well as equipments in the construction industry. In all these areas, embedded systems confer added value to the products by either extending the range of the delivered functionalities or by enhancing the quality of a "traditional" functionality that is rendered to the user.

The graduates of this program will have a holistic view on the specification, design, and implementation of complex embedded systems, taking issues such as resource-constraints, budget and development time into account. In addition to the technical skills, the EIT program offers insights on the elements of business and developing innovations into successful business ideas.

A distinctive feature of the program is that you study at two universities in two different institutions and in two different countries: you spend one year at the entry node taking the common base courses and part of your innovation and entrepreneurship module and then you move to the exit node for your specialization courses and your graduation project as well as the rest of the innovation and entrepreneurship module.

Graduation options

The EIT Embedded Systems program 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 (TUCS), Finland
- University of Trento (UNITN), Italy.

After being admitted to one of the entry nodes (KTH for EE students, TU Berlin for CE students and TU Eindhoven for CS students), during your second year, you will have the option of specializing in one of the following areas offered at the exit nodes:

- UNITN: Real-Time Embedded Systems
- 3TU (TU/e): Embedded Networking
- KTH: Embedded Platforms
- TUCS: Energy Efficient Computing
- Aalto: Mobile Cyber-Physical Systems
- TU Berlin: Embedded Multicore Processing

8.2.1 Goals

The general learning outcomes of the programme are:

- The graduate has a holistic, system-based and multi-disciplinary view on embedded systems, their development and their integration. She is able to formulate abstract views to understand embedded systems of great complexity. She is able to describe and study the structure and the behaviour of embedded systems with respect to both functional and non-functional behaviour, e.g., resource usage and dependability.
- The graduate has a thorough knowledge of contemporary techniques to realise embedded systems. She has sufficient academic background to understand and apply techniques that will become available within the next decades.
- The graduate has a sufficient basis for designing embedded systems at the required level of quality, or assessing feasibility. This supposes knowledge of requirement engineering, performance analysis, validation and testing, and implementation techniques. She is familiar with a range of realisation platforms, ranging from software to direct realisation in silicon. She knows of the life span of embedded systems, and of the role of architectures in this field. She is aware of costs and environmental issues, and capable of making optimal use of the available means.
- The graduate has a flexible and inquisitive mind. She understands the theories, techniques and tools in this field in such a way that he is able to adapt these to fit their purpose optimally. She is able to invent his own tools, theories and techniques if these are not available.
- The graduate is aware of her position and that of the embedded systems she constructs in society. She is aware of and has a responsible attitude concerning the impact of new technology on the economy, the environment, and the daily life of citizens. She is able to present and communicate her ideas and visions in a clear and concise way. She is also able to work in multidisciplinary design teams, a competence the industrial field of embedded systems is in great need of.

- The graduate has an understanding how technological innovations can be developed into successful business ideas. She is aware of the basic concepts of business organisation, product development, entrepreneurial finance, and market dynamics. She is also able to start up and manage a technology-based company and understands how to develop and lead human resources of such a company.

8.2.2 Entry point program

KTH, TU Berlin, and TU/e will offer an entry-point programme for the ES technical major. It consists of a *Technical Common Base*, an *(entry point) I&E module*, and *Electives*.

The following table summarises the TU/e entry-point programme as it will run in the academic year 2012-2013:

Quarter	Code	Unit	ECTS
1	2IN26	Real-time systems	5
1	5DD17	Circuit analysis	3
1	1ZS01	Technology entrepeneurship	3
1-2	5KK73	Embedded computer architecture	5
2	2IN27	Quantitative evaluation of embedded systems	5
2	5HH00	Electronics for embedded systems	3
2	1ZS02	Technology entrepeneurship: business plan development	3
3	2IW26	System validation	5
3-4	5KK03	Embedded systems laboratory	5
3-4	1ZM55	Service engineering and marketing	5
3-4		**Winter school**	3
4	1ZM80	New media, entrepreneurship and innovation	3
		Summer school*	4

*) The Summer School of 4 ECTS, which is counted as part of the entry-point programme will be organised centrally by the ESML.

8.2.3 Exit point program

Starting in 2013-2014, TU/e will offer an exit-point program with a specialisation in Embedded Networking.

The following table summarises the programme:

Quarter	Code	Unit	ECTS
1	2IN28	Grid and cloud computing	5
1	5ME20	Ubiquitous computing and activity recognition	5
2	2II45	Architecture of distributed systems	5
		Wireless sensor networks	5
		Electives	13

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Quarter	Code	Unit	ECTS
3-4		**I&E minor thesis**	6
3-4		**Master's thesis project**	30

Electives

The following courses are suitable as electives:

Quarter	Code	Unit	ECTS
2	5MY10	Wireless communication I	3
1	2IC35	Physical aspects of digital security	5
		Advances in networking	5
2	2IN95	Seminar system architecture and networking	5
		Measuring and simulating the internet	4
		Energy efficient embedded systems	5

Exit-point I&E module

The exit-point programme contributes 6 ECTS to the I&E module through the I&E Minor Thesis. The latter is planned to be a chapter in the Masters Thesis elaborating in detail on a business plan pertaining to the technical subject of the thesis.

Part III

Organization and regulations

9 Academic administration

9.1 Academic administration of the department

The structure of the academic organization is based on the Academic Administration Structure Modernization Act (MUB), as implemented in the academic year 1997-1998. A student may contribute to the improvement of the academic organization as a member or advisor on the Department Board, the Study-program Committee or the Department Council. Participation in these organizations offers special privileges, such as facilities for oral instead of written exams or extra opportunities for taking examinations outside regular scheduling.

Important organizations:

- The Department Board (Faculteitsbestuur);
- The Study-program Director (Opleidingsdirecteur);
- The Study-program Committee (Opleidingscommissie);
- The Examinations Committee (Examencommissie);
- The Department Council (Faculteitsraad);
- The CS Division and Professors (Capaciteitsgroep en Hoogleraren);
- The CS Division Board (Capaciteitsgroepsbestuur);
- The Department Office (Faculteitsbureau);
- The Student Council (Studentenraad).

9.1.1 Department Board of Mathematics and Computer Science

The Department Board appoints a study-program director for the graduate program, and a program manager for each master program. The study-program director and

program manager are mandated to develop, organize and implement the master program. Although some authority is delegated to the study-program director, the Department Board retains final responsibility for each master program. This means that the study-program director must report to the Department Board. The Department Board establishes the education and examination regulations (OER) and the program budget, and oversees the implementation of the master program. The Department Board is comprised of four members: the dean and chairperson, two vice-dean and division chairs and the managing director. A student advisor also participates in the board meetings, as advisor. Other attendees at the board meetings are the policy advisors and the department secretary.

The current members of the Department Board are:

Dean:	prof.dr. A.M. Cohen
Vice-deans:	prof.dr. O. Boxma and prof.dr.ir. E.H.L. Aarts
Managing director:	R.M.A. van de Donk

9.1.2 Study-program Director

Every year the study-program director outlines in the OER the academic program and policies, including the program structure and curriculum. He develops the program curriculum in close consultation with the teaching staff and the curriculum committee. The Study-program Committee advises the study-program director on his curriculum and quality plans. The study-program director is in charge of the development and implementation of a quality management system. The Study-program Committee advises the study-program director on his curriculum and quality plans. The study-program director advises the Division Board on the academic program. Whenever necessary, he also advises the Division Board on quality improvement and performance of the academic staff. The study-program director relies on the Department Office for administrative and managerial support. The Department Office also advises the study-program director on academic issues.

In the Computer Science graduate program, some of the responsibilities of the study-program director are delegated to program managers. Each master program has a program manager. The study-program director, the vice-director, and the program managers together form the Educational Board:

Study-program director:	prof.dr. M.T. de Berg
Vice-director:	dr. M.A. Westenberg
Program manager CSE:	dr. A. Serebrenik
Program manager BIS:	prof.dr.ir. W.M.P. van der Aalst
Program manager ES:	dr. M. Mousavi
Program manager IST:	dr. B. Skoric
Program manager SDE:	dr. B. Luttik

9.1.3 Study-program Committee

The study-program committee (OC) is appointed by the Department Board, and it has the following tasks:

- to advise the study-program director and the Department Board on issues relating to the OER
- to annually evaluate the implementation of the OER
- to advise on all issues relevant to the academic program

The department has three study-program committees: for the CSE program including the special tracks IST and EIT-SDE, for the BIS program, and for the ES program including the special track EIT-ES.

9.1.4 Examinations Committee

The Departmental Board appoints an Examinations Committee for each program. This committee is responsible for organizing and coordinating the examinations, and for appointing examiners in accordance with the provisions of Art. 7.12 of the Higher Education and Scientific Research Act 1997. Its members are all drawn from the Computer Science and Engineering teaching staff. The Examination Committee must approve the Examination Regulations to ensure the probity and integrity of all examinations, and will take all necessary measures in this regard. Its secretary is ms. J.M.L.G. Sanders.

9.1.5 Department Council

The Departmental Council has a statutory advisory function and certain decisions made by the Departmental Board require the formal approval of the Departmental Council. This will be the case if those decisions entail any amendment to department statutes, or the Education and Examination Regulations. The Departmental Council has ten members, of whom five are staff members who are elected by the staff, and five are students elected by students within the department.

You can find more information on the activities of the Department Council on their web site: `http://www.win.tue.nl/fr/`.

9.1.6 CS Division and professors

The general tasks of the CS Division are:

- to contribute to the preparation and implementation of the educational and exam programs
- to contribute to the research programs
- to contribute to the interdepartmental and inter-university education and research programs

In addition, the CS Division Board aims to come to agreement with the study-program director on issues of quantity and quality of academic staff.

The tasks of the professors are:

- to develop their assigned research areas
- to advise the study-program director and program manager on the contents of the educational program.

Division secretary: ms. M.M.W.G. van den Bosch-Zaat, phone number 040 247 5010
Staff members: a complete list is available on the web site

9.1.7 Department Office

The Department Board delegates day-to-day operations to the Department Office. The managing director heads the Department Office, which is sub-divided into six offices:

- Human Resource Management (HRM) Office
- Financial Services Office
- Computer Services Office (BCF)
- Management Support Office
- Education Office
- Public Relations

The managing director of the Department Office is R.M.A. van de Donk

Department Secretarial Services:
Head: M.P.M. de Faber
Secretarial assistant: P.C.J. Gudden-van den Boomen (040 247 2750)
General and janitorial services: J.W. Schellekens

HRM Office:
Head: P.J. Evers bc
Staff: J. Kamperman, C.M. van Dam, and L.G. van Kollenburg-Walraet

Financial Services Office:
Head: P.C.P. Geenen

Computer Services Office:
Head: drs. P.J.E.M. Coenen
Staff: R.L.M. Beckers, S. Hoop, V.B. Huijgen, and J.P.H. Hunnekens

Management Support Office:
Policy advisor Mathematics: ir. H.J.M. Wijers
Policy advisor Computer Science: dr. D.M. de Haan
Policy advisor Education: dr. E.F. Kaasschieter

Education Office:

Head:	ms. E. van den Hurk
International office:	ms. E. van den Hurk
Staff:	ms. J. Berger-van der Aalst, ms. J.M.L.G. Sanders, and ms. M.J.C.P. de Wit-van Geenen

Study advisors:

Bachelor study advisor:	dr. C.J. Bloo
Master study advisor:	dr. J.P. Veltkamp
Secretarial services:	ms. G. van der Linden-Cocu (CS) ms. C. Welten-Verhulst (Math)
Educationalist:	dr. J. C. Perrenet

Public relations:
Staff: drs. J.M.F. Horvath, drs. I.M.J. van Uden, and J.G.W. Klooster

9.1.8 Student Council

The Student Councils (StudentenRaad, SR) main goal is to help solve problems in the educational process, such as problems with examinations, time tables or professors. The SR also mediates in cases where individual students encounter problems, and it serves as a first information point for students who do not know who to go to if they have a question. In many cases, the SR can refer students to the right place. Students with complaints or questions can reach the SR in the following ways:

- During one of the biweekly meetings. For the most recent meeting schedule, please refer to `http://www.studentenraad.org`
- By e-mail: sr@win.tue.nl or complaints@gewis.nl
- By contacting the education commissary of GEWIS: oc@gewis.nl

Finally, the SR attempts to stimulate and facilitate contact among student members of the study program committee (OCI, ECM, OC-BIS, OC-CSE, OC-ES, OC-SEC), the Faculty Council (FR), University Council (UR) and the Student Advisory Body (SAO) and to discuss the items on the agendas of each of these bodies. This is why members of these bodies are always encouraged to be present at SR meetings.

9.2 Facilities

9.2.1 Buildings

The department of Mathematics and Computer Science is located in the upper five floors of MetaForum. Regulations on access to university buildings are described in the departmental chapter of the student statutes and on the use of computer rooms are

outlined on the website. For oral English explanation of these regulations, contact the Computer Services Office in room MF 3.083, telephone number (040)(247) 2802 or e-mail wshelp@win.tue.nl.

9.2.2 Lecture rooms, halls and other instruction facilities

The department uses lecture rooms within the whole university. Lecture rooms and halls are managed at institutional level by ms. M. de Voogd, Auditorium 2.08, telephone number (040)(247) 2645 or on e-mail zaalreserveringen@tue.nl. Reservations of the meeting and instruction rooms in MetaForum can be arranged through the department student administration, telephone number (040)(247) 2379/ 8343. Or on e-mail studadm.win@tue.nl.

9.2.3 Library services

The TU/e Library holds a large and up-to-date collection of scientific information. The TU/e Library website `http://www.tue.nl/library` provides round-the-clock access from any workplace to a wealth of digital information resources using advanced search tools. The TU/e Library collection is focused mainly on the technical sciences. Collection policy is linked directly to fields of research at TU/e departments.

The fully redeveloped and centralized TU/e Library is now located in MetaForum, the building in the centre of the campus. It provides the TU/e community with an inspiring and information-oriented environment for individual and collective study and work. There are over 950 study seats divided into quiet areas near the book collection and workspaces where groups of students can discuss their assignments. Each seat is equipped with wireless Internet access. Students may borrow publications from the Library free of charge using a fully automated loan system.

Regular opening hours of the TU/e Library are: Monday-Friday 8.00-22.30 h. and Saturday-Sunday 10.00-22.00 h. Even longer hours apply during examination periods. For all further information about TU/e Library service go to our website: `http://www.tue.nl/library`.

9.2.4 Sale of study materials

Study material can be bought at the Reproshop ("Dictatenverkoop"). Daily opening hours are from 8:30 to 16:30. The shop is closed during the introduction week. Inquiries can be made at: HG -1.42, telephone number (040)(247) 2446.

9.2.5 Computer Services Office

The Computer service office (BCF) is part of the department office. BCF is located in MF 3.083. The BCF-helpdesk is open on working days from 9.00 until 17.00 hrs, tel. (040) (247) 2802, e-mail: `wshelp@win.tue.nl`, Website: `http://www.win.tue.nl/bcf`

The tasks of the Computer Service Office (BCF) are:

- to provide computer facilities;
- to provide user support;
- to administer student accounts on the student server svstud, a Linux-server for the students of the department;
- and to manage the use of computer rooms

Students can print at printers on the third floor. Working locations for notebook use are available at the lower levels of MetaForum. Details on the regulations on the use of the computer facilities can be accessed at `http://w3.win.tue.nl/en/education/regulations/`

For problems with student e-mail accounts, please contact the ICT Information and Service Desk at LG 1.94, telephone number (040)(247) 4649. The Notebooks Help Desk is located at MF 3.083, telephone number (040)(247) 2979.

9.2.6 Conditions for computer use

The use of all computer and network facilities is subject to the rules listed in the document "Computer- en netwerkgebruik in ruimten van de faculteit W&I" (Computer and Network Use in Rooms of the Department of Mathematics and Computer Science), which can be downloaded from `http://www.win.tue.nl/bcf`. A copy is also available for inspection in the Computer Services Office. Use of any facilities implies your acceptance of these rules in full.

The department's policy is that students should be able to print program-related documents free of charge. There are four free printers available: one on the fifth floor and the others on the tenth floor. Usage is monitored and any student printing more than five hundred pages in any one year will be asked to explain. His or her account will be blocked if usage remains excessive and will only be reactivated on payment of 20 euros. The department considers photocopying unnecessary. Students with a PAS account can use the university printers and photocopiers. The PAS card can be topped up at the Computer Services Office in Room MF 3.083.

Any problems or technical faults with hardware or software should be reported to the Computer Services Office, as should any infractions of the rules governing the use of the computer rooms, computers and networks.

9.3 Study association GEWIS

The study association GEWIS (union of math- and computer-science students) was founded over 25 years ago. GEWIS champions student rights, promotes student interests and offers students extracurricular activities. It organizes excursions to national

companies and tries to organize an international study trip on a regular basis. It organizes the freshmen introduction week and the weekly drink on Thursdays from 16:30 until 19:00 in MF 3.155.

GEWIS publishes a magazine "Supremum", a yearbook, and organizes sporting events, (sailing-) weekends, parties and numerous other activities. On request, it is possible to organize an informal gathering at GEWIS. Every weekday from 12:30 to 13:30, GEWIS provides a book sale in MF 3.155, offering study books at reduced prices. In addition, the GEWIS-website offers old exams. The education commissary of GEWIS plays an important role as representative of students in the education processes.

GEWIS can be reached at: MF 3.155, telephone number (040)(247) 2815, e-mail: bestuur@gewis.nl and `http://www.gewis.nl`.

9.4 Information resources

Current information on program regulations, program changes, changes in the course schedules, practical courses, exams and other important matters is available as listed below.

Leading information on the program:

- The master program guide is digitally available.
- The Education and Examination Regulations and Examination Rules and Procedures are digitally available.

Personal contact at the department:

- The master study advisor: dr. J.P. Veltkamp
- Student Administration in room MF 3.068 (inquiries desk) or at telephone number (040)(247) 2379, for general information and inquiries about study arrangements, regulations, schedules and calendars and study results. The opening times of the inquiries desk are for students from 11:00 to 12:00, and from 13:00 to 15:00. More information can be found on website `http://www.win.tue.nl/student`
- International students coordinator: E. van den Hurk in room MF 3.068, telephone number (040)(247) 2752 or e-mail international.office.win@tue.nl
- The Study Association GEWIS is in room MF 3.155 or at telephone number (040)(247) 2815.

Personal contact at the university:

- The Education and Student Service Center is in room HG 0.72 or at telephone number (040)(247) 8015 for general information and inquiries about financial aid, student assistantships, admissions, university passes, exam regulations etc.

- International student affairs: International Office in room HG 0.72, telephone number (040)(247) 8015 or e-mail io@tue.nl.

Several internet sources of information are available:

- The website at http://www.tue.nl/ provides general TU/e information.
- Information about the department, academic counseling, social events and activities, etc. can be found at http://w3.win.tue.nl/.
- The electronic course catalog can be accessed at http://education.tue.nl/ and contains current course information. Also examinations and course schedules are available at this webpage.
- Information about education in computer science is available at http://www.win.tue.nl/masterprogramguide/regulations/
- Video recordings of lectures: http://videocollege.tue.nl/

A

Teaching and Examination Regulations

A.1 CSE

Available at the website: 

A.2 BIS

Available at the website: 

A.3 ES

Available at the website: 

B

Graduation checklist

1. **Submit study program** if you have accumulated 40–50 credits.

   Form 1:

   Make sure both you and your graduation supervisor sign the form. Submit a signed paper version at the student administration and a digital version (in Word-format, without signatures) to: studadm.win@tue.nl.

2. **Read the graduation regulations** before actually starting your graduation project.

   Graduation regulations:

3. **Submit your graduation plan** before actually starting your graduation project.

   Form 2:

   Gather all the required signatures on the form and make a separate problem description. Submit all documents to the student administration.

4. **Register for the examination meeting at the latest four weeks in advance**.

   Via `http://owinfo.tue.nl/`

5. **Compose the assessment committee** at the latest 1 month before your final presentation.

   Form 3:

   The *graduation supervisor* must assemble the commitee according to the regulations, gather all the required signatures on the form, and submit it to the student administration.

6. **Graduation presentation** at the latest 2 weeks before the examination meeting.

   You can book a room for your presentation at the student administration (provided all results of your study program are registered at the administration). After the presentation, your supervisor should submit your grade and an assessment report at the student administration.

7. **Fill in the "Graduation Form" (form 4)**, which you receive by e-mail from the student administration. Submit it signed 2 weeks before the examination meeting to the student administation. If applicable, please deliver your locker key as well.

8. **Print your graduation report** at the latest 1 week before the examination meeting. Hand in a digital version (on CD) in PDF at the student administration.

   Title page: 

   If your report should be confidential for 1 year or longer, have your supervisor sign the form "overeenkomst vertrouwelijk-verslag"  .

   You will receive the graduation enveloppe from the student administration.

9. **Fill in the graduation survey (only for CSE, BIS and ES students)**. You will get an e-mail with the link from the student administration.

10. **Come to the graduation ceremony**. You will get an e-mail with the invitation from the student administration.