Welcome

With pleasure we present you this booklet with the descriptions of the master’s programmes Computer Science, Telematics and Human Media Interaction of the University of Twente.

Most readers, we assume, will be familiar with the Computer Science field. You know about the Computer Science fundamentals. You are aware of the impact Computer Science has and has had on our society and our everyday life. In fact, you probably understand more of this impact than the average layman.

Master’s programmes are specialized. They are not about basic knowledge and skills in a broad area. They are about pushing boundaries; to gain (often relatively small) new insights, generally only in a small area. But each change contributes to the strength of the Computer Science field.

Pushing a boundary is hard work. You have to understand in detail what is going on at the edge of your field. There is a great variety of things that can slow down progress. Physics may seem to work against you, complexity and lack of proper analysis tools may be a hindrance, and of course all sorts of human factors can be a challenge. You have to be aware of methods and techniques that are available to solve the problems you encounter. And sometimes you simply have to get lucky: look at the obstacle that is in your way from the right perspective, and then you realize it is not an obstacle at all. There is a skill to develop here, one of the strong points of the creative expert is that he gets lucky more often than others.

In the course descriptions in this book you will not find the phrase “pushing boundaries”. But it is an important characteristic of taking a master’s degree. In a 120 EC programme, 2 years of full-time study, you learn what it is to push boundaries. And even if it does not look like it, that is what this book is about.

Dr. ir. Rom Langerak
Programme director Computer Science and Telematics

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Department of Computer Science

Since 2002 Computer Science has been a department within the Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS) of the University of Twente. The department is organized into chairs, each covering a distinguishing part of the broad field of computer science. In addition to being involved in scientific research, the Computer Science Chairs are also responsible for the curriculum of the Bachelor of Science programme Computer Science and the Master of Science programmes Computer Science, Human Media Interaction and Telematics.

In this guide you can find information about the following master’s programmes:

1. Master of Science in Computer Science
2. Master of Science in Telematics
3. Master of Science in Human Media Interaction

In chapter 4 of this study guide you can find information about the chairs and chair holders of the Computer Science department.
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SECTION A

Master’s programme
1 COMPUTER SCIENCE
You are already familiar with the developments in information and communication technology and now you want to improve your knowledge and skills in this rapidly changing field. You want to specialize in specific subjects of choice, join a research group, and gain relevant experience in industry. The MSc Computer Science programme offers you the opportunity for all this, preparing you for specialist functions in industry or for a PhD and a career in science. We offer five specializations in current fields of research: Computer Security, Software Engineering, Information System Engineering, Methods and Tools for Verification and Wireless and Sensor Systems. As a master’s student you can choose a direction close to technology or close to a field of application such as healthcare, dependable systems, or learning and knowledge management.

1.1 GOALS AND AIMS OF COMPUTER SCIENCE

The common goals for the specializations in the master’s programme in Computer Science are established in the course rules. Basically it comes to this: the master’s programme aims to combine a scientific mindset with specialist technical knowledge, enabling graduates to analyze, design, validate and implement state-of-the-art ICT systems in their operational context. Graduates of the master’s programme are trained to take a scientific, ethical and socially responsible approach to conducting and contributing to research in their specific area of study and to international trends in and related to their field of study. The master’s programme aims to offer an engaging and challenging, research-oriented academic environment, enabling students to:

• acquire extensive knowledge and insight; develop their professional and scientific mindset by taking the initiative in and assuming responsibility for the learning process
• develop an inquisitive and reflective attitude
• understand and gain practical experience with methods and technologies for modeling and describing systems and their properties
• acquire a knowledge of, understand and gain practical experience with taking stock of the requirements of ICT systems (i.e. technology, design, validation and implementation) and of promising alternatives, and take informed decisions
• develop a constructively critical attitude in which decisions are substantiated and discussed
• work as part of a team in applying and/or developing theories, methods, technologies and tools pertinent to the development of ICT systems in their operational context
• gain practical experience working in complex, dynamic settings in which the information required is not always immediately available or complete
• be encouraged by means of an engaging curriculum (involving case studies, research projects, and discussions about research, trends and literature relevant to the discipline) to follow the trends in their field and use this information as a guide for and incorporate it into their own personal development.

The master’s programme also aims to encourage students who have the necessary affinity with and demonstrated talent for scientific research to continue on to pursue doctoral research. The course rules state the following domain-specific goals for the CSC programme. The CSC master’s programme strives to achieve the aims described further on.

The CS master’s programme focuses on three themes:
• development of ICT systems in their commercial context
• technological aspects and applications of embedded systems
• development process of sophisticated software systems

Students will acquire specialist knowledge in one of these areas. The CSC master’s programme is designed for students with a thorough understanding of technology and of the functional and qualitative properties of systems and ability to evaluate and predict these properties and their context dependencies. System security, performance and efficiency are key areas of focus.

1.1.1 General scientific attainment levels

Graduates of the master’s programmes in the department of Computer Science will be able to meet the following scientific attainment targets:

a. Graduates have an extensive knowledge of and understand the issues relevant to their specific field of study (i.e. programme-specific attainment targets) described under 2 below.

b. Graduates can contribute to scientific research, and independently design, conduct and present the results of small-scale research.

c. Graduates can provide an original contribution to the development and/or application of the field of study.

d. Graduates can analyse complex problems (change problems) relevant to the field of study and obtain the required knowledge and information.

e. Graduates can design, validate and implement solutions/systems in their operational context; identify and apply relevant advanced knowledge, methods and techniques from their field of study.

f. Graduates can assess solutions/systems and their applications according to their properties and potential to solve problems even if they are new to or unfamiliar with the situation or lack information and/or reliable information; they can use their assessment as a basis for (substantiation of) decisions.

g. Graduates understand the ethical, social, cultural and public aspects of problems and solutions in their field of study; apply this insight in their international role as scholar.

h. Graduates can work as part of and play a leading role in a team; manage and plan a development process; document development and research processes.

i. Graduates can substantiate research results, designs and applications in writing and verbally; critically assess and participate in debates regarding the same.

j. Graduates can independently acquire new knowledge and skills; reflect on trends in their field of study, responsibilities and roles and use this insight as a guide for and integrate it into their own personal development.

k. Graduates can integrate information from other disciplines into their own work if necessary.

l. Graduates take a critical approach to reading, incorporating information presented in and participating in debates regarding international scientific literature relevant to their field of study.

The word ‘original’ in c is understood to mean ‘demonstrative of a creative contribution’, and not ‘pioneering’. 
1.1.2 Computer Science specific attainment levels

The final attainment levels of the Computer Science programme are in line with the Dublin descriptors:

a. Knowledge and understanding:
The graduates have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with Bachelor’s level, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context;

b. Application of knowledge and understanding:
The graduates can apply their knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study

c. Formulate judgement:
The graduates have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements;

d. Communication:
The graduates can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;

e. Learning skills:
The graduates have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

In addition to the general attainment targets, CSC graduates will command a high level of scientific knowledge and understanding of computer science. This is demonstrated by their extensive knowledge and understanding of the technical aspects and design of ICT systems. In addition to a thorough understanding of these issues, CSC graduates also have a specialist knowledge and understanding of the chosen track

1.2 GENERAL OUTLINE

There are six general rules to be observed by the student and study adviser in assessing the student’s possible course programme choices and in signing the finalized course programme. These general rules work differently according to programme, graduation subject field and track. See also section 1.3 of this guide.

1. The student creates a programme of units of study totalling 120 credits. These units are selected from among the courses offered by the UT or, where beneficial, courses offered by other universities. All course programmes except for graduate school students have to include Computer Ethics (191612680, 5 credits), a 30-credit graduation assignment, and a 10-credit research project. Graduate school students have to include Computer Ethics (191612680, 5 credits), a 15 credit international research orientation/internship and a 30 credit graduation assignment. The Examination Board may grant a student (not a graduate school student) exemption from the mandatory 5 credits Computer Ethics and/or the 10 credits research project.

2. The admissions board may grant a student admission with additional requirements, imposing additional diploma eligibility requirements. These requirements differ from student to student. No more than 30 credits will be required to satisfy the conditions imposed by the admissions board. The Master’s programme final assessment cannot be passed if the course programme of this category of students does not satisfy the additional requirements imposed. There are no exceptions to this rule.

3. Requirements apply to each course programme to ensure basic knowledge in the field of study and the track selected. The admissions board may adjust these requirements on the basis of the student’s prior education and training. Such an adjustment will never entail an intensification of the requirements. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the basic knowledge requirements. The only exception to this rule is when the admissions board lowers the basic knowledge requirements.

4. Requirements apply to each course programme to ensure sufficient depth of study in the track selected. The manner in which these requirements are satisfied is determined in consultation with the study adviser. This includes, where necessary, taking into account which chairs will bear responsibility for the student’s graduation supervision. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the depth of study requirements. There are no exceptions to this rule.

5. Requirements apply to some course programmes governing the chair from which the student can complete his/her studies, according to the graduation subject field or track selected. The Master’s programme final assessment cannot be passed if, during the course of study, the requirements for the composition of the graduation committee are not satisfied. There are no exceptions to this rule.

6. One guideline applicable to all course programmes is that continuing students (i.e. holders of a UT Bachelor’s diploma eligible for automatic admission to one of the Master’s programmes) complete part of the programme’s 120 credits outside of the UT. The Examination Board may decide to exempt an individual from this guideline.

The total number of credits completed at the UT or at another university or research institute approved by the study adviser, must be at least 90. The Examination Board may permit a student to deviate from this rule. Additional requirements with regard to the type of activities completed by students outside of the UT may be posed. For instance, the obligation that a student complete a traineeship. Such a requirement must involve no more than 30 credits. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the requirements imposed with regard to the units of study completed outside of the UT, unless an exemption has been granted.
1.3 MASTER’S PROGRAMME
The master’s programme of Computer Science has five specializations. In the following paragraphs each specialization will be described.

1.3.1 Computer Security
Our society is dominated by the increasing role of computerised systems. However, as a side effect, the society becomes increasingly vulnerable to misuse of such systems. A large number of private Windows computers are infected with malware, privacy-leaks are commonplace in the Internet, and highly sophisticated malware like Stuxnet is targeting industrial installations. This explains the growing interest and importance of computer security and privacy protection. The Kerckhoffs’s Computer Security specialization aims at educating those who will occupy the leading positions in this field.

Programme mentor:
Prof.dr. P.H. (Pieter) Hartel
Room: Zilverling 3001; Phone: 53 489 2411; E-mail: pieter.hartel@utwente.nl

This is a joint programme of three Dutch universities: the Radboud University Nijmegen (RU), the Technical University Eindhoven (TU/e) and the University Twente (UT). Participating students will have to take subjects and sit interim examinations at other universities. Some of the courses are given as tele-lectures. The general aim is that students travel one day per week to another university and attend local courses or tele-lectures on the other days of the week.

Content of the course programme:
Six basic subjects
192194100 Cryptography 1 (TU/e, 6EC)
192195200 Security in Organizations (RU, 6EC)
192195100 Software Security (RU, 6EC)
192194200 Verification of Security Protocols (TU/e, 6EC)
201100023 Security and Privacy in Mobile Systems (UT, 6EC)
201100086 Network security for Kerckhoffs students (UT, 6EC)

At least three of the following ten advanced subjects
191210901 Introduction to Biometrics (UT, 6EC)
192111091 Secure data management (UT, 6EC)
192195400 (Privacy) Seminar (RU, 6EC)
192194110 Cryptography 2 (TU/e, 6EC)
192195300 Hardware and operating systems security (RU, 6EC)
192195500 Law in cyberspace (RU, 6EC)
192194310 Linux kernel and hacker’s hut (TU/e, 6EC)
192194400 Seminar Information Security Theory (TU/e, 6EC)
201100021 Cyber-Crime Science (UT, 6EC)
201200007 Economics and Security (UT, 6EC)

1 Mandatory for students starting in the academic year 2011 or later.

1.3.2 Information Systems Engineering
Today’s organizations are vitally dependent on their information systems, and the high demands placed on these systems require skilled technical specialists. “Information Systems Engineering” graduates are experts and can be found at all stages of a distributed information system’s lifecycle (requirement analysis, architecture design, realization and maintenance). The information systems of today’s organizations manage large volumes of internal information, including structured and sensor data, multimedia data or geographic information. These systems encompass workflow, groupware and e-business processes and are often distributed across organizational units and physical locations. Information system engineers are able to combine and configure basic software components, such as database management systems, transaction processing monitors, workflow management systems and middleware. In short, they know how to define a system on which an organization can truly depend without giving rise to any vulnerabilities.

Programme mentor:
Dr. A. (Andreas) Wombacher
Room: Zilverling 3098; Phone: 053 489 3772; E-mail:a.wombacher@utwente.nl

Content of the course programme:
4 basic subjects
192110902 Advanced Database systems
192110982 Database transactions and processes
192320111 Architecture of information systems
192320820 Design science methodology

At least one of the following 9 basic subjects
201200044 Managing Big Data
192110880 Sensor Data Management 1
192110941 Secure Data management
192110961 XML & Databases 1
192150300 Security in Information Services
192320501 E-commerce

Elective subjects
Other subjects to obtain the minimally required number of 120 credits may be chosen from the subjects offered by other specializations.

Mandatory (45 EC)
191612680 Computer Ethics (5 EC)
192199508 Research Topics (10 EC)
192199978 Final Project (30 EC)

A special way to fulfill the requirements of Computer Security specialization is by successfully completing the course programme on SAP in the EITICT Masterschool where the second year is done at University Twente. Details on the programme are found on: http://eitictlabs.masterschool.eu/programme/majors/sap/

Graduation supervision is organized by the programme mentor.
Computer science

The course programme includes the following unit of study:

**Basic subjects**

- 192340041 Software management

**At least 20 ECTS of the following advanced subjects**

- 192110880/61 XML & databases 1/2
- 192110880/90 Sensor data management 1/2
- 192160400 Information retrieval
- 192320220 Advanced architecture of information systems
- 192320850 Advanced requirements engineering (follow up modules)

**Elective subjects**

Other subjects to obtain the minimally required number of 120 credits may be chosen from the subjects offered by other specializations.

**Mandatory (45 EC)**

- 192166500 Computer Ethics (5 EC)
- 192199508 Research Topics (10 EC)
- 192199978 Final Project (30 EC)

Graduation supervision is organized by the following chairs: Information Systems or Databases.

### 1.3.3 Software Engineering

In our daily life we are surrounded by devices like television sets, DVD players, mobile phones, etc. These devices are actually computer systems that execute software programs in order to perform their functions. The proper working of these devices, therefore, strongly depends on the proper working of the software, which these devices execute. Since these devices are proliferating and interacting with other systems in order to serve us in a multitude of ways and circumstances, the quality of software already plays a crucial role in our lives.

Therefore, Software Engineering focuses on applying techniques, guidelines, concepts, methods and tools that increase the quality of software in different products. The quality factors include, for example, performance, reliability, robustness and maintainability. The desired set of qualities usually conflict with each other and lead to trade-off decisions. The intricacies and intertwining of software qualities in different sorts of software systems make Software Engineering challenging and stimulating.

The Software Engineering programme covers the state-of-the-art topics necessary to design and maintain high quality software systems. Graduates of this programme will be able to create successful software systems that will have the right balance of the desired qualities.

**Programme mentor:**

Dr. ing. C.M. (Christoph) Bockisch

Room: Zilverling 5098, Phone: 053 489 3918; E-mail: c.m.bockisch@utwente.nl
1.3.4 Methods and Tools for Verification
The Methods and Tools for Verification (MTV) programme is targeted towards ambitious computer science students, who want to become

- validation engineers, who know a broad range of validation techniques and tools, and know when and how to apply these techniques and tools within a system’s life cycle, and/or
- researchers, who want to do theoretical and foundational research in the realm of formal methods, and/or
- tool builders, who are able to implement formal theories into working tools, which then can assist system- and validation engineers in developing correct systems.

Apart from the general attainment levels for the CSC Master, MTV graduates demonstrate their specialist knowledge as follows.

- MTV graduates have a thorough knowledge of and understand the scope of formal methods as a scientific and design discipline.
- MTV graduates have a thorough knowledge of, understand and gain practical experience with the application of formal methods and tools in the development process of software, distributed and/or embedded systems.
- MTV graduates can apply formal methods and tools during system design on the basis of knowledge and insight, make an informed selection of these and contribute to their further development.
- MTV graduates have knowledge of and understand various aspects of theoretical computer science, including process algebra, type theory, proof systems and formal testing theory.
- MTV graduates have specialist knowledge and understanding of one or more sub-fields or aspects of the formal methods discipline, e.g. Process Algebra, Software Model Checking, Distributed Model Checking, Program Verification, Proof Systems, Testing, Quantitative Modeling and/or Analysis, Graph Transformations, Game Theory.
- MTV graduates have practical experience conducting scientific research into formal methods, contribute to such research, apply the results, follow the trends of this sub-field and contribute to its further development.

Programme mentor:
The Formal Methods and Tools (FMT) group is responsible for the MTV Master programme. The MTV Master programme is closely related to the CTIT research theme Dependable Systems and Networks (DSN). See also the related Twente Graduate school Programme Dependable and Secure Computing.

Dr. M. (Marieke) Huisman
Room: Zilverling 5031; Phone: 053 489 4662; E-mail: m.huisman@utwente.nl

The course programme includes the following units of study:

4 basic subjects
192111092  Advanced Logic
192135310  Modeling and Analysis of Concurrent Systems 1
192140122  System Validation
192170015  Testing Techniques

At least three of the following 8 basic subjects
192135450  ADSA- Model driven engineering
192111233  Aspect oriented Programming
192130092  Fault tolerant digital systems
191520751  Graph Theory
191560561  Introduction to mathematical systems theory
192661001  Patterns of software development
201200006  Quantitative Evaluation of Embedded Systems
192620300  Performance evaluation
191210341  Physical Systems Modelling of ES
191580752  Deterministic models in OR
191580251  Mathematical Programming

Advanced subjects
192114300  Program Verification
192135320  Modelling and Analysis of Concurrent Systems 2

At least 10EC from the following advanced subjects
192114100  Principles of Model checking
192114200  Quantitative modeling and analysis
192117700  Computability and Computational Complexity
192110280  Advanced Programming Concepts
191581420  Optimization Modelling
191210441  Control engineering

Elective subjects a 20EC

Mandatory (45 EC)
192166500  Computer Ethics (5 EC)
192199508  Research Topics (10 EC)
192199978  Final Project (30 EC)

Graduation supervision is organized by the chair of Formal Methods and Tools.

1.3.5 Wireless and Sensor Systems
The Wireless and Sensor Systems programme addresses a new paradigm for bringing the flexibility of information technology to bear in every aspect of daily life. It foresees that people will be surrounded by embedded and flexibly (wirelessly) networked systems that provide easily accessible yet unobtrusive support for an open-ended range of activities, to enrich daily life and to increase productivity at work. These systems contain a mixture of hardware and software: their scope may be as simple as a sensor, or as complex as a portable device, or even an entire building or city. Cooperation is a necessity, to perform their tasks with sufficient quality or efficiency, and to reach the required functionality and support real time interactions.
The specific nature of these systems require them to be open, scalable, adaptable and dependable, while integrating heterogeneous devices ranging from tiny actuators to larger computers. The programme WiSe studies not only the fundamentals of wireless and sensor systems, but also the context of the sensor systems. To this end, WiSe is a multidisciplinary and application oriented programme where you come in contact with different (technical as well as non-technical) disciplines and by doing so, it stimulates cooperation.

The WiSe master's programme can also be followed as a Twente Graduate School Programme.

Programme mentor:
ir. Hans Scholten / prof.dr. P.J.M. (Paul) Havinga
Room: Zilverling 4016; Phone: 053 489 3733; E-mail: hans.scholten@utwente.nl

The course programme includes the following units of study:

**Five compulsory core courses (25 EC)**
- 192620010 Mobile & Wireless Networking I
- 191210750 System on Chip Design for ES
- 191211030 Ubiquitous Computing
- 192340041 Wireless Sensor Networks
- 192166500 Computer Ethics

**Three elective courses (15 EC) out of the following**
- 192130112 Distributed Systems
- 191211030 Mobile Radio Communication
- 192620300 Performance Evaluation I
- 192620020 Mobile And Wireless Networking II
- 191210590 Embedded Signal Processing
- 192110880 Sensor Data Management

**Elective courses (total 30 EC)**
- 191211208 Internship (20 EC, not for HBO students)

**Courses (10/30 EC) on topics related to:**
- Flexible and efficient communication
- Distributed wireless systems
- Distributed data processing and reasoning

**Graduation (40 EC)**
- 191211749 Individual project (10 EC)
- 192199978 Final Project (30 EC)

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1.3.6  **Twente Graduate School**

The Twente Graduate School at the University of Twente offers an increasing variety of integrated master’s and PhD programmes for outstanding graduate students who aim at a career in scientific research. The programmes are set up in cooperation between faculties and research institutes. Through a broad selection of compulsory and elective courses, students are able to specialize in a research area of their interest and at the same to broaden their perspective on the societal context of technology and research. All these aspects are integrated into the Twente Graduate School (TGS) which aims to become a breeding ground for research talent. TGS sets high standards and has a strict selection procedure for both research and education programmes as well as prospective students.

The structure of a graduate research programme includes a cursory component at master level that forms the basis for research concerning the subject in question, an international orientation on research, a preparatory and orientating master’s project, a cursory component provided by the involved research institute, the national research schools and/or other (inter)national networks, a number of broadening subjects such as ethics and philosophy, innovation and entrepreneurship, governance and project management, science and communication, etc., and a research project resulting in a doctoral degree.

A schematic overview of the building blocks of a graduate research programme:

For the master's programme of Computer Science, TGS has four specializations. In the following paragraphs each specialization will be described.
1.3.6.1 Wireless and Sensor Systems
The Graduate Programme Wireless and Sensor Systems (WiSe) can be followed as a specialization programme within the master’s programme of Computer Science, as well as a specialization within the Twente Graduate School programme. For an overview of the WiSe programme see paragraph 1.3.5 of this study guide.

Programme mentor:
ir. Hans Scholten / prof.dr. P.J.M. (Paul) Havinga
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This graduate school program is supported by the Design and Analysis of Communication Systems group (DACS), the Distributed and Embedded Security group (DIES), the Formal Methods and Tools group (FMT), and the Software Engineering group (SE).

1.3.6.2 Dependable and Secure Computing
ICT systems are used as part of an ever-growing variety of applications and form a critical backbone of our societal infrastructure. Malfunctioning or sabotage of ICT systems incur economic expenses at best, cost lives at worse, or will even disrupt society.

An ICT-system is called dependable if reliance can justifiably be placed on the services it delivers. This should be possible despite the occurrence of physical faults, communication problems, software errors, human operator mistakes, or attacks by malicious intruders.

Dependability and security are interpreted in a broad sense. Depending on the application domain, it includes 7x24 availability, absolute safe and timely behavior, a guaranteed quality-of-service level, the protection of the integrity of financial transactions, enforcement of digital rights and the privacy of users.

Dependable ICT is a challenge, because applications tend to be geographically distributed, have increasingly complex and adaptive functionality, are connected via wired or wireless networks, and should be open for interaction with an unknown, sometimes malicious, environment.

In this Computer Science Graduate programme you will learn and develop traditional and novel methods and techniques for analyzing and constructing dependable and secure systems. Traditional means are fault and intrusion detection, prevention, prediction, removal, and tolerance, so that systems keep working even despite faults, errors, or hackers. Emphasis will be put on computational methods, in the following areas:

- Modeling, automated analysis and synthesis of dependable systems;
- Algorithms and protocols to enforce dependability and security;
- Design of dependable and secure software architectures.

Programme mentor:
Dr. M. (Marieke) Huisman
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The course programme includes the following units of study:

Compulsory core courses (25 EC)
192130092 Faulttolerant Digital Systems
192140122 System Validation
192194200 Verification of Security Protocols (TU/e, 6EC)
192111332 Design of Software Architectures
191210441 Control Engineering

And depending on choice of track (30 EC):
Track Dependability Modeling and Evaluation (DME)
192135310 Modeling and Analysis of Concurrent Systems 1
192135320 Modeling and Analysis of Concurrent Systems 2
192114200 Quantitative Modeling and Analysis
192135450 ADSA Model Driven Engineering
191580752 Deterministic Models in OR
192130500 Performance Evaluation

Track Secure Networks (SN)
192654000 Network Security
192110941 Secure Data Management
192620010 Mobile and Wireless Networking 1
192194100 Cryptography 1 (TU/e)
201100021 Cyber-crime Science
192130300 Performance Evaluation

Track Dependable Software Synthesis (DSS)
192661001 Patterns of Software Development
192111233 Aspect Oriented Programming
192170015 Testing Techniques
192135450 ADSA Model Driven Engineering
192114300 Program Verification
192135310 Modeling and Analysis of Concurrent Systems 1

Elective courses (15 EC):
These consist of:
- courses in the other tracks of “Dependable and Secure Computing”
- courses from the following list
- other courses in consultation with the programme mentor

Listed courses
19211092 Advanced Logic (FMT)
192110280 Advanced Programming Concepts (SE)
192111700 Computability and Computational complexity (HMI)
192130112 Distributed systems (PS)
The subject of the Graduate programme Human-IT is the interaction between humans and ICT. It considers both the interaction of humans with the system and the interaction between humans through the technology.

The rapidly grown availability and use of ICT in all aspects of the personal, organizational and societal life sphere during work, learning or free time, calls for a multidisciplinary and interdisciplinary approach of the subject, in which computer science and other engineering disciplines team up with social sciences and the humanities. This is fully reflected in this Graduate programme. The Graduate programme considers the technological, psychological, sociological and philosophical dimensions of human-media interaction.

The core research concerns the design of intelligent interactive systems that improve the quality of the user experience as part of a human-centred development process. Besides the technological perspective this will thus involve considering the human in the loop. Therefore, also the assumptions underlying design and development (as they relate to ethical considerations for instance), the acceptance and use and the impact and implications of the technology on the direct interaction of humans with the system and the impact on a societal level are considered.

The technical and engineering programmes involved in the Graduate programme have an interest in building more and more involved computational models of users and user context for interpreting signals and processes that are considered meaningful for humans and for artificial intelligent interactive systems in some particular practice. A considerable research effort is spent attempting to interpret a user’s state of mind (by interpreting natural language text and speech, body language or brain signals, for instance) and acting upon this appropriately. To build such computational models, systems also resort more and more to the analysis of gigantic repositories of user interactions, such as user clicks logs, query logs, etc.

From the psychological and communicative perspective, the Graduate programme brings challenging questions to the fore about how meaning (embodied in the interface, content, actions, etc) is created, transferred and adapted in ICT-mediated environments, including questions of causal relations between technological or representational design decisions on the one hand and effects and affective impact on the other hand. From a cognitive-ergonomic point of view it is important to understand the neuro-cognitive possibilities and limitations of humans as they interact with conspecifics and technology. A firm grasp on cognitive strength and weaknesses of humans will allow for the design of interactive systems that act when humans cannot and efficiently support humans in areas where they already excel.

Programme mentor:
Dr. D. (Dirk) Heylen.
Room: Zilverling, room 2031; Phone: 053 489 3745; E-mail: d.k.j.heylen@utwente.nl.

Depending on the track chosen by the student, the MSc phase can either be 1 or 2 years.

The Master phase of the project fulfills the requirements of one of the Master programmes participating in the Graduate Programme (either the MSc HMI – see chapter 3 of this study guide, or the MSc Computer Science, specialization Information Systems Engineering – see paragraph 1.3.2 of this study guide).

For more information about the course programme, please contact the programme mentor or check the following website: www.utwente.nl/tgs/programmes/human-centredinteractiontechnologies/

1.3.6.4 Services Science

Services science has emerged from the realization that the economy of physical products is being replaced by an economy of services that can be delivered with these goods. Information technology is the key enabling factor in this. It enables further globalization of commerce and production, but at the same time global connectedness in a service economy introduces new levels of architectural complexity and security risks, that need to be managed.

Nowadays services can be found everywhere and experienced and used anytime, in daily life, professional life, at consumer and business levels, and at technology levels. Traditional examples are transportation services, health services and education services.

Some newer examples are ICT outsourcing services, in which design or programming tasks are outsourced to specialized companies, and helpdesk services, which concentrate large numbers of calls from clients asking for help with products. We observe nowadays a trend to package products in services, so that added value can be offered to potential clients. An example is in contract manufacturing, such as for the automotive industry, where parts and equipment are provided on behalf of an original equipment manufacturer, possibly covering a range of activities such as design, prototyping, assembly, and quality assurance for complete products.

ICT is an enabler for the further growth of the services sector. Most business services and processes are supported by ICT services. The shift from products to services often implies an ICT-enabled provision of e-services. High-speed networks and powerful computer systems have made these processes ubiquitous.

From the methodological side, the advent of the Service-Oriented Architecture has facilitated the mapping from business processes to ICT services, with the benefits of effectiveness and flexibility.

Services are essential, important and becoming quite complex as more interrelated services appear and more stakeholders or parties get involved. This means that services have to be approached from scientific, management and engineering points of view. Our Services Science programme has Management Science and Computer Science as cornerstones. It offers two study tracks, one going through a BIT Master and the other going through an CS Master, with each track following the rules of its related master’s programme, but having a clear ‘services science’ signature.
Programme mentor:
Prof. dr. R.J. (Roel) Wieringa
Room: Zilverling 3063; Phone: 053 489 4189; E-mail: r.j.wieringa@utwente.nl

The course programme includes the following units of study:

Four compulsory courses
192320111 Architecture of Information Systems
192110902 Advanced Database Systems
192320501 Electronic Commerce
192111332 Design of Software Architecture

Five courses in Track A: Services technologies
192652150 Service-Oriented Architecture with Web Services
192110982 Database Transactions and Processes
192330301 Specification of Information Systems
192110961 XML & Databases 1
192135450 ADSA- Model Driven Engineering

Five courses in Track B: Services in business
192376500 Business Process Integration Lab
193160060 Information & Knowledge Exchange Services
194108040 Business Development in Networks
192320201 Data Warehousing & Data Mining
192320820 Design Science Methodology

Four elective courses
a. Compulsory courses from the other tracks.
b. Courses from the following list:
192320220 Advanced Architecture of Information Systems
192320850 Advanced Requirements Engineering
192376000 Business Case Development for IT-projects
192340070 Computer Supported Cooperative Work
192404600 E-Government: communication and organization
192350200 E-Strategizing
192360021 ICT Management
192340101 Implementation of IT in Organizations
194105070 Information Systems for the Financial Services Industry
193163010 Information and Knowledge Management
191863970 Information Systems Design Methodologies
192652110 Java Middleware Technologies
192160200 Knowledge Representation
193190000 Managing Service Organizations
192631000 Mobile E-health Applications and Services
191852640 Production & Logistics Information Systems

Mandatory (55 EC):
• Individual specialization assignment for Track A or B (5 EC)
• 191612680 Computer Ethics (5 EC)
• International research orientation/internship (15 EC)
• Master thesis (including research proposal) (30 EC)

1.4 PROGRAMME GUIDELINES

The student must complete the following steps to obtain course programme approval:

1. Orientation
Students complete subjects and sit interim examinations as they see fit. In this phase only a few credits can be earned. During this phase, the student can be advised by the admissions board or, if the choice of track is clear, by a programme mentor (per specialization, see section 1.3). If the student chooses subjects or projects during orientation without consultation of the admissions board or a programme mentor, he/she does so at his/her own risk. If 15 credits have been earned in the master’s programme, the orientation ends. At this point, permission from a programme mentor is required for a more complete programme of at least one year. Phase 2 begins. In case the student during orientation chooses only subjects and projects which are mandatory for any course programme (within a given graduation subject field or track), consultation with and approval by a programme mentor may be postponed to a maximum of 30 credits. No one can earn more than 30 credits in phase 1.

2. Approval of initial choices
After receiving approval from the programme mentor, at least 60 credits of the course programme to be completed or already partially completed are laid down. The choice of graduation subject field or track is clear, as is the matter of whether a traineeship will be included in the course programme. The manner in which the credits for optional units of study are to be allocated and the chair/chairs from which the student will graduate may still be not entirely clear.

3. Approval of entire course programme
The programme mentor approves the 120-credit course programme in its entirety. At this point it is clear which chair/chairs will bear responsibility for the student’s graduation supervision. Students may reduce the term of Phase 1 and skip Phase 2. Regardless of how the student wishes to proceed, once the limit established for the orientation phase has been reached (i.e. 15 programme credits earned or 30 credits for mandatory units of study only), the programme mentor must be contacted.
1.5 SPECIAL PROGRAMME COMPONENTS

1.5.1 Pre-master

**Computer Science**

In case you have a BSc in Computer Science from the University of Twente, Delft University of Technology or Eindhoven University of Technology you have full, unconditional admission to the master’s programme in Computer Science of the University of Twente. In case you have a BSc degree in Computer Science from a different university in Holland or a professional master’s degree (HBO) in Computer Science you can apply for admission at the Admission Office, see www.utwente.nl/admissionoffice. The Admission Office will decide if you can be admitted to the programme. By checking your previous programme on the aspects of programming, software engineering, computer architecture/organization, operating systems, information systems, databases and on some discrete mathematics, they will decide if a pre-master’s programme is necessary.

If so this pre-master’s programme has to be finished successfully before one gets full admission to the master’s programmester’s programme will at least contain the course on algorithms, and courses on the aspects mentioned above that are lacking. In case there is too much discrepancy no pre-master’s programme will be allowed, and no admission is possible.

**Telematics**

In case you have a BSc in Computer Science from University Twente, Technical University Delft or Technical University Eindhoven you have full, unconditional admission to our master’s programme in Telematics. In case you have a BSc degree from a different university in Holland in Computer Science or a professional master’s degree (HBO) in computer science or electrical engineering you can apply for admittance and the admission committee will judge if you can be admitted.

The committee will check your programme on the aspects of programming, software engineering, computer architecture/organization, operating systems, information systems, databases, telematics systems and mathematics.

If so this pre-master’s programme has to be finished successfully before one gets full admission to the master’s programmester’s programme will at least contain the course on algorithms, and courses on the aspects mentioned above that are lacking. In case there is too much discrepancy no pre-master’s programme will be allowed, and no admission is possible.

1.5.2 Traineeship

During the traineeship (external training) you apply your knowledge that you acquired in your master’s programme, working at a company or institution. The purpose is to work under circumstances resembling the situation after your graduation as much as possible. Included in this working experience is also the process of finding a position and a short application procedure. The traineeship has a study load of 20 EC and will last at least 14 weeks.

**Organization**

The following persons and organizations play a role during your traineeship:

- The host organization, which is the company or institution where you will carry out the traineeship. The host organization assigns a staff member who will supervise your work.
- The Educational Supervisor is a lecturer of your master’s programme. He/she will monitor the scientific level of your traineeship. The Educational Supervisor should give approval to the traineeship before you make your final appointments with the host organization. After the traineeship, he/she will carry out the final assessment and decide about the mark.
- The traineeship office, which consists of the traineeship coordinator and the mediator. They will supervise the student from the beginning of the searching process finding a position until the end of the traineeship, when the last documents should be archived.

**Options for a traineeship**

Most students usually find a traineeship position at a company, but also an institution or university is possible. A traineeship can be done everywhere in the world; in Enschede but also in New Zealand or somewhere in between. “The sky is the limit”, unless you manage to find a position with NASA or ESA as an astronaut. The only place on earth definitely out of scope is the UT itself. In all cases, the host institute should provide an assignment that must be approved by the educational supervisor. Approval will only be given if the assignment has sufficient academic level.

**How to find a position**

One might distinguish three ways to find a host institute:

1. The database of the traineeship office: the office maintains databases containing companies and experience reports. These reports are written by students and describe their experiences during the traineeship.
2. A lecturer in a chair (research group): during research, lecturers often cooperate with companies and institutions that might also be willing to provide a traineeship position.
3. On your own: it is possible and allowed to find a traineeship position on your own. Many companies offer traineeship positions on their websites. Finding a position in this way may not be easy but it may lead to a surprising and rewarding traineeship.

In all cases the traineeship must be approved by a lecturer before you make your final appointments with the host institute. This is described above.

**Information sessions**

Twice a year information sessions are held about the traineeship, in September and April. You can find them in the timetables of the master’s programmes.

**First contact**

Make an appointment with the traineeship mediator (stages@utwente.nl) if you start to think about a traineeship. During this meeting, the procedure will be discussed and a planning will be made for the preparation, the traineeship itself and the completion after return. See your mediator at least six months before you plan to go. After this meeting, the Blackboard site with training positions will be opened for you.
1.5.3 Final Project

The final project is a 30-credit project completed over a half-year period, which rounds off the Master’s programme. It is a research and/or development exercise. While the final project is frequently an individual project, some students choose to complete the assignment in groups of two or more. The final project may be developed and implemented internally (within the UT), it may also involve a commissioned assignment from a company or another higher education institution. Some projects are completed abroad. The project usually follows a preceding Research topics. The final project is a ‘Master’s test’. In completing the project, the student demonstrates that he/she merits the Master of Science qualification.

While the substance of the assignment focuses on a specified field of study, it is assessed on the basis of a number of criteria. The following factors are key in earning a satisfactory result for the graduation assignment: to be able to clearly formulate a problem statement, to be able to identify relevant literature, to be able to draw up a work plan, to be able to adjust problem statement and work schedule in accordance with interim evaluations, to be able to analyse different possible solutions and to motivate a choice between them, to be able to communicate the research and design activities both written and in presentations, to show the ability of reflection on the problem, on the research/design approach, on the solution and on one’s own performance, and finally to demonstrate creativity and the ability to work independently.

The final project should enable the student to apply the expertise gained during prior courses, projects and practical training sessions to solve well-defined problems of sufficient academic difficulty. In completing the final project, students must be allowed to make their own decisions. Students must be able to address the problem systematically, achieve clear results and formulate clear conclusions. Students are expected to report, both orally and in writing, on their findings and read and process relevant literature critically. Students who choose the combined traineeship and final project may use part of their credits to focus on the project themec before leaving and work on their report after their return.

At the beginning of the final project, the student and the graduation supervisor make work agreements. The graduation supervisor ensures that the assignment is in line with the ‘mission’ of the student’s chosen specialization and arranges for adequate supervision. The student will meet with the supervisors regularly to discuss the progress of the final project. These meetings focus on both the content and the implementation of the final project (comparable to the job appraisal interviews students will encounter later in their career).

To complete the final project, the student must submit a written report and hold a public presentation. The report should also contain a text reflecting upon the relevance of the research work of the final project in the society.

The student contacts a chair, willing to take responsibility for the development, organization and supervision of the project and/or an external organization where the project can be performed. The programme mentor can help you find a chair. The chair can help you making arrangements with external organizations. The following conditions must be met prior to definitive admission to the final project:

- The programme mentor has approved the student’s course programme.
- A chair/chairs willing to take responsibility for the organization, supervision and assessment of the graduation project has/have been found.
- Outside of the final project or combined traineeship and final project, the student requires no more than 10 credits to be eligible for the master’s programme final assessment.

The programme mentor is responsible for ensuring that there is proper supervision and evaluation during the course of the final project.

Web references: www.utwente.nl/csci/programmeinformation/

1.5.4 Study Abroad

A student is allowed to study 30 credits externally. To gain international experience a student is given the chance to go abroad to another university or institute to follow courses or doing projects. The choice of courses or projects has to be approved by the programme mentor in the same way as the other part of the programme is approved.

Carrying out a traineeship abroad (as described in par. 1.5.2) is one way of gaining international experience. In some cases it is possible to carry out the final project abroad under joint supervision, where the lead in supervision will always be taken by the own chair. Our faculty has agreements with partner universities and institutes to accommodate students smoothly. Information about going abroad to partner or non-partner universities/institutes, the procedures and the possibilities of financial support can be given by the coordinator of internationalization:

Drs. J. (Jan) Schut.
Room: Zilverling A-108 Phone: +31 53 489 4350; E-mail: j.schut@utwente.nl

1.5.5. Teaching degree

Graduates of the MSc Science Education and Communication – specialization Computer Science Education – receive the teaching license in computer science in secondary education. This master degree can be obtained as a second master degree, together with the master’s programme of Computer Science, Embedded Systems or Human Media Interaction. Combining these two programmes takes an extra year. Students get an extra year of study finance. More information can be given by drs. N.M. (Nico) van Diepen, didactician computer science; e-mail: n.m.vandiepen@utwente.nl. See also: www.utwente.nl/master/sec/
1.6 ORGANIZATION

1.6.1 Programme Director

The programme director for the master’s programme Computer Science is dr. ir. R. (Rom) Langerak. You can find him in building Zilverling, room 5039; Phone: +31 53 489 3714; E-mail: r.langerak@utwente.nl

1.6.2 Programme Coordinator

The programme coordinator for the master’s programme Computer Science is drs. J. (Jan) Schut. You can find him in building Zilverling, room A 108; Phone: +31 53 489 4350, E-mail: j.schut@utwente.nl

1.6.3 Programme Mentor

The diploma is earned by obtaining satisfactory assessment results for each of the various units of study. The Examination Board ultimately determines whether the student’s results make him/her eligible for the diploma. This determination includes an assessment of whether the subjects and projects completed satisfy the applicable requirements and whether the level of the results achieved merit the diploma. The student has a great deal of freedom in selecting the subjects and projects completed towards earning the diploma. The entire list of units of study selected and completed by the student is called the course programme.

The conditions placed on selecting subjects and projects are sometimes easy to meet, but is still mandatory in all cases that the student obtains formal approval for the choices he/she makes.

The Examination Board appoints programme mentors who, on its behalf, assess the choices made by students in completing their programme according to the applicable regulations and any additional requirements imposed by the admissions board. If assessed positively, the programme mentors then approve the students’ course programmes on behalf of the Examination Board.

The course programme conditions are presented in the ‘Course Programmes’ section below. The conditions placed on the course programmes differ according to programme, track and specialization.

Every programme has its own programme mentor. Programmes offering various specializations and graduation subject fields generally have programme mentors for each specialization and graduation field.

Computer Security
prof. dr. P.H. (Pieter) Hartel
Room: Zilverling 3001; Phone: +31 53 489 2411; Email: pieter.hartel@utwente.nl

Information Systems Engineering
Dr. A. (Andreas) Wombacher
Room: Zilverling 3098; Phone: +31 53 489 3772; Email: a.wombacher@twente.nl

Methods and Tools for Verification
Dr. M. (Marieke) Huisman
Room: Zilverling 5031; Phone: +31 53 489 4662; Email: m.huisman@utwente.nl

Software Engineering
dr. ing. C.M. (Christoph) Bockisch
Room: Zilverling 5098, Phone: +31 53 489 3918; Email: c.m.bockisch@ewi.utwente.nl

Wireless and Sensor Systems
ir. Hans Scholten
Room: Zilverling 4016; Phone: +31 53 489 3733; E-mail: hans.scholten@utwente.nl
prof. dr. P.J.M. (Paul) Havinga
Room: Zilverling 4010; Phone: +31 53 489 4619; Email: p.j.m.havinga@utwente.nl

1.6.4 Coordinator International Students

The coordinator for international students is drs. J. (Jan) Schut. He can be contacted for any questions about the programme; Room Zilverling A 108; Phone +31 53 489 4350; E-mail j.schut@utwente.nl

1.6.5 Study adviser

The study adviser supports students during (study) problems that they might encounter. Besides programme-related problems, students can contact the study adviser for questions about studying, planning, complaints, educational and examination regulations and your legal position. The study adviser is the confidant for students.

The study adviser for Computer Science is L. (Lilian) Spijker; Room Zilverling 1005; Phone: +31 53 489 3493; E-mail: l.spijker@utwente.nl
2 TELEMATICS
2.1 GOALS AND AIMS OF TELEMATICS

Telematics focuses on improving the interaction between people and/or automated processes over time and distance through the application of information and communication technology. Telematics lays the foundation for connecting today's demanding users worldwide. Ever increasing bandwidth, growing mobility, new applications every day, a variety of standards having to work together without problems: these all are challenges for the telematics expert.

In order to meet these challenges, the telematics expert needs knowledge about and insight in a broad range of topics: fixed/wired and mobile/wireless networking technologies; design methods and performance evaluation tools; network management and security issues; and of course services and applications.

The telematics programme ensures that students familiarize themselves with all core topics in telematics, while also offering them a choice of relevant courses that focus more on specific aspects. The programme does not have a formal set of specializations to choose from; instead, each student composes his/her own programme, within some given constraints (see programme guidelines), and subject to approval by the programme mentor. Thus, each student can tune the programme to his/her interests and ambitions.

2.1.1 General scientific attainment levels

The Telematics programme has the following general scientific attainment levels. These describe the general academic skills (not specific to Telematics) that a student acquires in the program.

a. Graduates have an extensive knowledge of and understand the issues relevant to their specific field of study (as detailed in section 2.1.2).

b. Graduates can contribute to scientific research, and independently design, conduct and present the results of small-scale research.

c. Graduates can provide an original contribution to the development and/or application of the field of study.

d. Graduates can analyse complex problems (change problems) relevant to the field of study and obtain the required knowledge and information.

e. Graduates can design, validate and implement solutions/systems in their operational context; identify and apply relevant advanced knowledge, methods and techniques from their field of study.

f. Graduates can assess solutions/systems and their applications according to their properties and potential to solve problems even if they are new to or unfamiliar with the situation or lack information and/or reliable information; they can use their assessment as a basis for (substantiation of) decisions.

g. Graduates understand the ethical, social, cultural and public aspects of problems and solutions in their field of study; apply this insight in their international role as scholar.

h. Graduates can work as part of and play a leading role in a team; manage and plan a development process; document development and research processes.

i. Graduates can substantiate research results, designs and applications in writing and verbally; critically assess and participate in debates regarding the same.

These skills describe the knowledge and understanding of technology, development and application of data transmission, data communication, networks, protocols and their interrelations.

j. Graduates can independently acquire new knowledge and skills; reflect on trends in their field of study, responsibilities and roles and use this insight as a guide for and integrate it into their own personal development.

k. Graduates can integrate information from other disciplines into their own work if necessary.

l. Graduates take a critical approach to reading, incorporating information presented in and participating in debates regarding international scientific literature relevant to their field of study.

The word ‘original’ in c is understood to mean ‘demonstrative of a creative contribution’, and not ‘pioneering’.

2.1.2 Telematics-specific attainment levels

The qualification under ‘a’ in the preceding section, that graduates command a high level of scientific knowledge and understanding of Telematics, is demonstrated by their ability to:

TEL 1. apply in a structured manner, disseminate and incorporate in multidisciplinary projects extensive knowledge and understanding of technology, development and application of data transmission, data communication, networks, protocols and their interrelations,

TEL 2. maintain a comprehensive overview of and analyze the telematics service and application needs of organizations, incorporate these needs into the telematics application development process and integrate them into business processes,

TEL 3. assess sophisticated problems in the field of telematics, develop solutions/solution structures for them and translate these into concrete designs and implementation,

TEL 4. have a thorough knowledge of, understand and gain practical experience with the process and available methods and technologies for planning, managing and implementing system development for telematics systems and applications,

TEL 5. apply methods, techniques and design and development tools for the development of telematics applications, networks and services, make an informed selection of these, communicate the principles involved and contribute to their further development,

TEL 6. select and implement the methods, techniques and tools to formally specify, verify and test telematics systems,

TEL 7. have knowledge of and understand various aspects of telematics systems, including performance, security and reliability; be able to apply this knowledge,

TEL 8. integrate, both independently and as part of a team, telematics systems, services and networks into large-scale telematics infrastructures, and maintain a comprehensive overview of the consequences,

TEL 9. have knowledge of and understand the trends in the field of study and the interaction between technological innovations and the organizational context of their applications.

Telematics graduates have specialist knowledge of telematics and practical experience with scientific research and are able to contribute and apply the results.
2.2 GENERAL OUTLINE

The total size of the master’s programme is 120 EC (European Credits, where 1 Credit represents 28 hours of work), spread over 2 years. The first year is filled with regular courses, some of which are obligatory (25 EC, see section 2.3.1), some can be chosen within certain constraints (30 EC, see section 2.3.2), and some of which can be chosen freely (albeit subject to approval by the programme mentor). The second year may contain some more regular courses, and may contain a 20 EC traineeship (i.e., working for a few months at a company). It definitely contains the 30 EC final project, and the 10 EC ‘research topics’, which is usually a literature study as a preparation to the final project.

In contrast to some of the other programs of the department, the Telematics programme does not have predefined specializations to choose from. Instead, tuning your programme to the specific area within Telematics that you are most interested in, is done on an individual basis, in discussion with the programme-mentor.

The admission committee may have imposed extra constraints on your study programme, to ensure a good match between your bachelor programme and the Telematics master programme. Such extra constraints come in two flavors:

1. Homologation courses: these are courses that you have to include in your programme, in the space for free courses. Thus, they fall within the 120 EC of the total programme.
2. Deficiency or pre-master courses: these are courses that you have to do in addition to the 120 EC of the regular programme.

2.3 MASTER’S PROGRAMME

4 core courses (20 EC)
192620010 Mobile and wireless networking 1
192620300 Performance evaluation
192852150 Service oriented architecture with web services
192854000 Network security

at least 1 (min. 5 EC) of the following advanced courses on modelling and validation
201200006 Quantitative Evaluation of Embedded Systems
192140122 System validation
192170015 Testing techniques

at least 2 (min 10 EC) of the following advanced courses on networking technologies
192111710 Core networks
192620020 Mobile and wireless networking 2
192620250 Selected topics in P2P systems
192653100 Internet management and measurement

zero or more advanced courses chosen from the following list, such that the advanced courses in total (i.e., including the ones chosen from the above two lists) are at least 30 EC
191210780 Modern Communication Systems
191210800 Information Theory
191211030 Mobile radio communications
192110880 Sensor data management 1
192111301 Ubiquitous computing
192114200 Quantitative Modeling and Analysis
192135450 ADSA Model Driven Engineering
192140700 The numbers tell the tale (meten = weten)
192194300 Linux kernel and hacker’s hut
192195200 Security in organisations
192320111 Architecture of information services
192631000 Mobile e-health applications and services
192661001 Patterns of software development

elective subjects (min. 25 EC)
Other courses to obtain the minimally required number of 120 credits may be chosen from the courses offered by the university, subject to approval by the programme mentor. An internship of 20 EC may be part of this.

mandatory (45 EC)
191612680 Computer Ethics (5 EC)
192199508 Research Topics (10 EC)
192199978 Final Project (30 EC)

2.4 PROGRAMME GUIDELINES

Guidelines for organizing your study programme for Telematics are the same as those for the Computer Science programme; see section 1.4 of this guide.

These guidelines concern both practical issues such as how and when to plan which courses you take, and some formal rules about the composition of your course package, taking courses abroad, etc.

2.5 SPECIAL PROGRAMME COMPONENTS

For more information on the possibility and procedures for a pre-master’s programme, including a traineeship in your programme, the preparation and organization of the final project, the possibility of studying abroad, and the possibility of obtaining a teaching degree, you are referred to section 1.5 in the Computer Science part of this guide.
2.6 ORGANIZATION

2.6.1 Programme Director
The programme director for the master’s programme Telematics is dr. ir. R. (Rom) Langerak. You can find him in building Zilverling, room 5039;
Phone: +31 53 489 3714; E-mail: r.langerak@utwente.nl

2.6.2 Programme Coordinator
The programme coordinator for the master’s programme Telematics is drs. J. (Jan) Schut. You can find him in building Zilverling, room A 108;
Phone: +31 53 489 4350, E-mail: j.schut@utwente.nl

2.6.3 Programme Mentor
The programme mentor for the master’s programme Telematics is dr. ir. P.T. (Pieter-Tjerk) de Boer. You can find him in building Zilverling, room 5016;
Phone: +31 53 489 4327; E-mail: ptdeboer@utwente.nl.
You can make an appointment with him:
• if you are interested in following master’s programme Telematics.
• if you would like to tailor the master’s programme Telematics to your specific needs.
• to discuss and get approval for the courses you intend to follow as part of your master’s programme Telematics. Note that getting approval (thus a signature) is a requirement; see also the rules about this above.

2.6.4 Coordinator International Students
The coordinator for international students is drs. J. (Jan) Schut. He can be contacted for any questions about the programme. Room Zilverling A 108; Phone: +31 53 489 4350;
E-mail: j.schut@utwente.nl

2.6.5 Study Adviser
The study adviser for Computer Science is L. (Lilian) Spijker. She supports students during (study) problems that might encounter.

If you have any questions about programme-related problems, planning, complaints, educational and examination regulations, your legal position or if you want to talk about private matters that are of influence to your study and/or well being you can contact her: Room Zilverling 1005; Phone: +31 53 4893493; E-mail: l.spijker@utwente.nl
3 HUMAN MEDIA INTERACTION
3.1 GOALS AND AIMS of Human Media Interaction

Highlighting the interaction between people and technology, the HMI master's programme studies this relationship from different perspectives. Special emphasis is placed on the manner in which people interact with technology (i.e. what are their requirements, abilities and limitations?) and on the identification of the best way to implement or further develop technical capabilities to meet the needs of users.

The HMI master's programme focuses specifically on intelligent, multimodal systems offering a more natural form of interaction than currently possible with conventional monitors, mice and keyboards. By employing a broad range of input modalities to observe and intelligently interpret user actions, these intelligent interactive systems aim to automatically determine the user objectives and operational context and make the necessary adjustments. This multimodality applies both to system input and output; text, speech, haptic and visual feedback and all manner of communication media are integrated and presented to users in an intelligent manner.

The HMI programme combines technical expertise and skills in the field of interaction technology with knowledge and skills in user-oriented design methodologies and an understanding of how people interact with technology.

In collaboration with the University of Trento, Italy, the HMI programme also offers the possibility for students with technology knowledge and skills in user-oriented design methodologies and an understanding of how people interact with technology to obtain a double degree.

3.1.1 General scientific attainment levels

The degree programme has the following general scientific attainment levels

a. Graduates have an extensive knowledge of and understand the issues relevant to their specific field of study.

b. Graduates can contribute to scientific research, and independently design, conduct and present the results of small-scale research.

c. Graduates can provide an original contribution to the development and/or application of the field of study.

d. Graduates can analyze complex problems (change problems) relevant to the field of study and obtain the required knowledge and information.

e. Graduates can design, validate and implement solutions/systems in their operational context; identify and apply relevant advanced knowledge, methods and techniques from their field of study.

f. Graduates can assess solutions/systems and their applications according to their properties and potential to solve problems even if they are new to or unfamiliar with the situation or lack information and/or reliable information; they can use their assessment as a basis for (substantiation of) decisions.

g. Graduates understand the ethical, social, cultural and public aspects of problems and solutions in their field of study; apply this insight in their international role as scholar.

h. Graduates can work as part of and play a leading role in a team; manage and plan a development process; document development and research processes.

i. Graduates can substantiate research results, designs and applications in writing and verbally; critically assess and participate in debates regarding the same.

j. Graduates can independently acquire new knowledge and skills; reflect on trends in their field of study, responsibilities and roles and use this insight as a guide for and integrate it into their own personal development.

k. Graduates can integrate information from other disciplines into their own work if necessary.

l. Graduates take a critical approach to reading, incorporating information presented in and participating in debates regarding international scientific literature relevant to their field of study.

The word 'original' in c is understood to mean 'demonstrative of a creative contribution', and not 'pioneering'.

3.1.2 Human Media Interaction specific attainment levels

a. The qualification under ‘a’ above, that HMI graduates command a high level of scientific knowledge and understanding of human media interaction, is elaborated as follows.

b. Graduates have a thorough knowledge and understandings of each of the sub-fields listed below and identify and utilize any links:

- methodology of user-oriented design, including the drafting of user requirements, user studies and usability engineering;
- forms of natural interaction, including natural language and speech recognition technology, multimodal interaction and interaction via dialogue systems and conversational agents;
- intelligent interaction employing techniques taken from artificial intelligence, e.g. intelligent multi-agent systems and learning systems;
- media technologies, e.g. image processing, computer vision, graphics and virtual reality, enabling complex interaction.

c. Graduates can design, both independently and as part of a team, sophisticated applications involving digital media and interactive systems and geared to the needs of users.

d. Graduates can use state-of-the-art techniques, methods and design and development tools in developing sophisticated applications make an informed selection of and contribute to the further development of these methods, techniques and tools.

e. Graduates have knowledge of and gain practical experience with interaction design methods.

f. Graduates have knowledge of and understand various aspects of the user context of digital media and interactive systems and, based on this, communicate effectively and efficiently with users during the various phases of the development process.

g. Graduates have knowledge of and understand basic questions and research methods into human behavior (psychology and philosophy) and grasp the relevance of these fields of study to the design of interactive systems.

h. Graduates can draft, transfer, document and communicate to technical designers specifications on the basis of a knowledge and understanding of the technical aspects of digital media and interactive systems.

i. Graduates can assess systems for human media interaction according to their technical and operational aspects, incorporating a thorough knowledge and understanding of mathematics.
HMI graduates have specialist knowledge of one or more of the four Human Media Interaction sub-fields outlined above and practical experience conducting, reporting about and applying the results of scientific research in developing innovative interactive systems and the relevant techniques and methods.

3.2 GENERAL OUTLINE

Staff and students use the name HMI to refer to the Human Media Interaction programme. The HMI curriculum is a two year curriculum with a study load of 120 credits (EC) in total. Each year comprises 60 EC.

The composition of the course programme is as follows:

- Basic subjects, 40-50 credits,
- Advanced subjects, 0-40 credits,
- Elective subjects, 0-40 credits,
- (Research) traineeship and/or Research topics, 10-40 credits,
- Graduation work, 30 credits.

- Each student has an individual course programme which meets the programme requirements and general guidelines (section 3.3 and 3.4).
- The regulations for the approval of the student’s course programme (within the rules and restrictions of the programme) are in section 3.4.
- The Examination Board appoints a programme mentor to advise students in their choices. The programme mentor will have the authority to approve student’s programmes on behalf of the Examination Board.
- In addition to the programme students who will be admitted to the programme on the basis of a Bachelor’s degree awarded by a Dutch institute of professional education (HBO) must also complete a pre-Master’s programme. See the description in section 3.5

Graduate school students

The requirements set in (section 3.3) and in the general guidelines define Graduate School students as a particular type of student, to whom other requirements may apply than the general requirements for all students. Graduate School students are students who have been admitted to the Human Centred Interaction Technologies (HCIT) programme of the Twente Graduate School, and for whom the HMI master’s programme constitutes the initial phase of their HCIT programme. For more information about Twente Graduate School and the HCIT specialization, see section 1.3.6.

Trento Double Degree

The requirements set in (section 3.3) and in the general guidelines (section 3.4) distinguish Trento Double Degree students (shortly TDD students as a particular type of student, to whom other requirements may apply than the general requirements for all students. Trento Double Degree students are students who participate in the double degree agreement of the University of Twente HMI programme and the University of Trento (Italy) LMI (Language and Multimodal Interaction) programme. TDD students are either TDD entry students, who study their first year in Twente and their second year in Trento, or TDD exit students, who study their first year in Trento and their second year in Twente. See section 3.5.6 for more information about the double degree programme.

3.3 MASTER’S PROGRAMME

A choice of units becomes a course programme once it has been laid down, with the approval of the programme mentor. The programme mentor has the authority to refuse his approval even if the choice of subjects is within the limitations of the Regulations. This section gives a short overview of the regulations. The official rules and regulations can be found in the OER (teaching regulations) of the HMI programme. These regulations are available at the Office for Educational Affairs (BOZ) or at www.utwente.nl/ewi/en/education/oer.

3.3.1 Basic subjects

Students must choose their basic courses among the core units of Table 1, totaling 40 EC in study load. Graduate School students must make their choice totaling 50 EC in study load. The choice for all students is limited by the following rules. (The implication of these rules for Trento Double Degree students is outlined after Table 1.)

- It is mandatory that Computer Ethics (191612680) is among the basic subjects. It counts as a subject in the area Man, Media and Society.
- The basic courses must include a HMI project (192166100).  
- The basic subjects must include units in the area Human Computer Interaction with a study load of at least 5 EC in total.
- The basic subjects must include units in the area Artificial Intelligence with a study load of at least 5 EC in total.
- The basic subjects must include units in the area Man, Media and Society with a study load of at least 10 EC and at most 15 EC in total (including Computer Ethics).
- The subjects marked i-- in Table 1 are ‘introductory’ units of study. The number of introductory units of study included in the basic subjects is limited by the following rule: The course program can include no more than 30 credits from ‘introductory’ units of study.

For Graduate School students an additional requirement is imposed: The basic courses of a Graduate School student must include all units in the Human Centered IT area.

For Trento Double Degree students an additional requirement is imposed.

Trento Double Degree students must take courses of the LMI programme in the areas of Artificial Intelligence, Man, Media and Society, and Natural Interaction upon instruction of the programme mentor. Moreover, their course programme should contain

- Units in the area Human Computer Interaction (5 EC or more).
- Computer Ethics (191612680)
- An HMI project (192166100).

It is possible to have more than one instance of a unit of study in a course programme (e.g. HMI project, Capita Selecta). Of course the approval of the programme mentor is needed. The difference between the two must be clear to all parties.
HuMan Media interaction

Prerequisites:
To be eligible for 192166320 Speech and language processing 2 the student must have successfully completed 192166310 Speech and language processing 1.

Assessment and marking:
The ‘Assessment method’ columns use the following codes:
S  written interim examination
O  written assignment: detailed exercises, a report, an essay or other written document reviewed and assessed by the examiner, but not in the presence of the student
Pre presentation: information presented by the student before an audience, usually other students.

These codes are used to give a general indication of the assessment method of each unit of study, not outline the exact rules governing the form of assessment.

3.3.2 Advanced courses
Advanced courses are units of study chosen from the core HMI units in Table 1 that are not included in the basic subjects described in section 3.3.1.
The choice of courses is limited by the following rules:
• Advanced courses include no introductory units.
• The course programme includes no more than 15 EC units in the area Man, Media and Society.

3.3.3 Elective courses and homologation courses
Elective courses are courses not taken from Table 1. They are chosen upon advice of the programme mentor.
The choice of courses is limited by the following rule: The course programme includes no more than 15 EC units in the area Man, Media and Society.
In some cases the admissions board may issue a certificate of admission with additional requirements. Generally the student will use the space for elective courses in his course programme to meet these additional requirements, usually called ‘homologation’. Consequently he can take less or no elective courses.

3.3.4 (Research) Traineeship, research topics
1. Graduate school students must take a 15 EC research traineeship in their course programme.
2. Trento Double Degree students must take the 6 EC Research design course at Trento in their course programme.
3. All students except Graduate School students may take a 20 EC traineeship in their course programme. A student who must take homologation courses can skip a traineeship to make space for the homologation.
4. All students except the Graduate School students and the Trento Double Degree students must take a 10 EC Research topics subject in their course programme.

### Table 1: Basic courses and their areas

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**An -i- indicates an introductory unit**

3 Courses in this area may be subject to change, for an more up-to-date overview: www.utwente.nl/hmi
4 Courses in italics are mandatory items in any course programme
3.4 PROGRAMME GUIDELINES

There are six general rules to be observed by the student and programme mentor in assessing the student’s possible course programme choices and in signing the finalised course programme. These general rules work differently according to programme, graduation subject field and track.

1. The student creates a programme of units of study totalling 120 credits. These units are selected from among the courses offered by the UT or, where beneficial, courses offered by other universities. All course programmes except for Graduate School and Trento Double Degree students have to include a 30-credit graduation assignment, and a 10-credit Research Topics unit. Graduate School students have to include a 15-credit research internship and a 30-credit graduation assignment. Trento Double Degree students have to include the 6 credits Trento course Research design, and the 30-credit graduation assignment. Students with a course programme totalling fewer than 120 credits or one lacking a graduation assignment of at least 30 credits will not successfully pass the Master’s programme final assessment. There are no exceptions to this rule, except that the Examination Board may grant a student exemption from the mandatory 10 credits Research Topics.

2. The admissions board may grant a student admission with additional requirements, imposing additional diploma eligibility requirements. These requirements differ from student to student. No more than 30 credits will be required to satisfy the conditions imposed by the admissions board. The Master’s programme final assessment cannot be passed if the course programme of this category of students does not satisfy the additional requirements imposed. There are no exceptions to this rule.

3. Requirements apply to each course programme to ensure basic knowledge in the field of study and the track selected. The admissions board may adjust these requirements on the basis of the student’s prior education and training. Such an adjustment will never entail an intensification of the requirements. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the basic knowledge requirements. The only exception to this rule is when the admissions board lowers the basic knowledge requirements.

4. Requirements apply to each course programme to ensure sufficient depth of study in the track selected. The manner in which these requirements are satisfied is determined in consultation with the study adviser. This includes, where necessary, taking into account which chair/chairs will bear responsibility for the student’s graduation supervision. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the depth of study requirements. There are no exceptions to this rule.

5. Requirements apply to some course programmes governing the chair from which the student can complete his/her studies, according to the graduation subject field or track selected. The Master’s programme final assessment cannot be passed if, during the course of study, the requirements for composition of the graduation committee are not satisfied. There are no exceptions to this rule.

6. One guideline applicable to all course programmes is that continuing students (i.e., holders of a UT Bachelor’s diploma eligible for automatic admission to one of the Master’s programmes) complete part of the programme’s 120 credits outside of the UT. The Examination Board may decide to exempt an individual from this guideline. The total number of credits completed at the UT or at another university or research institute approved by the study adviser must be at least 90, except for Trento Double Degree students, who complete at least 60 credits at the UT. The Examination Board may permit a student to deviate from this rule. Additional requirements with regard to the type of activities completed by students outside of the UT may be posed. For instance, the obligation that a student completes a traineeship. Such a requirement must involve no more than 30 credits. The Master’s programme final assessment cannot be passed if the course programme does not satisfy the requirements imposed with regard to the units of study completed outside of the UT, unless an exemption has been granted.

3.4.1 Course programme approval procedure

- The student contacts the programme mentor as soon as possible to discuss the choice of subjects in the different categories (basic, advanced, and elective). Standard forms for laying down the course programme are available from the Educational support office secretariat and on the website of the Faculty of EEMCS.
- Once the programme and student reach an agreement on the content of the course programme, they complete and sign the forms. The programme mentor signs on behalf of the Examination Board.
- The programme mentor has the authority to refuse his approval to a proposed course programme, even if the choice of subjects is within the limitations of the Regulations.
- If the programme mentor decides to approve of a course programme which violates these regulations, he needs explicit permission of the Examination Board.
- The completed and signed form listing the course programme must be included in the student’s file at S&O / BOZ (the Student & Education service centre / Office of Educational Affairs EEMCS).
- In principle, the student will earn the programme diploma if he/she completes the units of study listed in the course programme and earns results in line with the guidelines for passing the final assessment.
- If the course programme listed on a signed form does not satisfy the regulations described in the teaching and examination regulations and/or does not satisfy the conditions imposed by the admissions board, the Examination Board is authorised to impose additional diploma eligibility requirements. In case the Examination Board has given the programme mentor the explicit permission to deviate from these regulations, this authority does not apply.

The student must complete the following steps to obtain course programme approval:

1. Orientation

Students complete subjects and sit interim examinations as they see fit. In this phase only a few credits can be earned. During this phase, the student can be advised by the admissions board or, if the choice of track is clear, by a programme mentor (section 3.6). If the student chooses subjects or projects during orientation without consultation of the admissions board or a programme mentor, he/she does so at his/her own risk.

If 15 credits have been earned in the master’s programme, the orientation ends. At this point, permission from a programme mentor is required for a more complete programme of at least one year. Phase 2 begins.

In case the student during orientation chooses only subjects and projects which are mandatory for any course programme (within a given graduation subject field or track), consultation with and approval by a programme mentor may be postponed to a maximum of 30 credits. No one can earn more than 30 credits in phase 1.
2. Approval of initial choices

After receiving approval from the programme mentor, at least 60 credits of the course programme to be completed or already partially completed are laid down. The choice of graduation subject field or track is clear, as is the matter of whether a traineeship will be included in the course programme. The manner in which the credits for optional units of study are to be allocated and the chair/chairs from which the student will graduate may still be not entirely clear.

3. Approval of entire course programme

The programme mentor approves the 120-credit course programme in its entirety. At this point it is clear which chair/chairs will bear responsibility for the student’s graduation supervision.

Students may reduce the term of Phase 1 and skip Phase 2. Regardless of how the student wishes to proceed, once the limit established for the orientation phase has been reached (i.e. 15 programme credits earned or 30 credits for mandatory units of study only), the programme mentor must be contacted.

3.5 SPECIAL PROGRAMME COMPONENTS

3.5.1 Premaster

In case you have a BSc in Computer Science from a Dutch university you have full, unconditional, admission to our master’s programme in Human Media Interaction. In case you have a different bachelor’s degree or a professional master’s degree (HBO) in Computer Science you can apply for admittance at the Admission Office, see www.utwente.nl/admissionoffice. The same goes for having a bachelor’s degree or professional master’s degree in a discipline in Artificial Intelligence, Mediatechnology, Creative Technology, Design and whatever you judge could be equivalent here. The admission committee will judge whether you can be admitted to the programme.

The committee will check your programme on the aspects of programming, software engineering, computerarchitecture/organization, operating systems, information systems, databases, artificial intelligence and on mathematics.

Based on this the Admission Office will come up with a pre-master’s programme consisting of courses on the aspects mentioned above that are lacking. In case there is too much discrepancy no pre-master’s programme will be allowed, and no admission is possible.

Applicants who satisfy the following three requirements are eligible for admission to the HMI Master’s programme.

a. The applicant is holder of a diploma from Saxion Universities (Saxion Hogeschool Enschede) demonstrating that he has satisfied the requirements of the final assessment of the Computer Science (Informatica) Bachelor’s programme or the Technical Computer Science (Technische Informatica) Bachelor’s programme.

b. The applicant has successfully completed the Advanced Algorithms elective module as part of his bachelor’s course programme.

c. The applicant, according to UT records, has sat the interim examination of either the subject 192140250 ADC plus or the subject 192140200 ADC while completing the Advanced Algorithms elective module and received a mark of 6, 7, 8, 9 or 10 or, if no mark is awarded, ‘pass’ (‘G’ in Dutch)

Applicants who satisfy the following requirements are eligible for admission to the HMI Master’s programme.

a. The applicant is holder of a diploma from the University of Twente demonstrating that he has satisfied the requirements of the final assessment of the Advanced Technology Bachelor’s programme.

b. The applicant has successfully completed the following electives as part of his bachelor’s course programme:

   192135000 Programmeren 1
   192135050 Programmeren 2
   19214090 Inleiding mens machine interactie
   192140250 Algoritmen, Datastructuren en Complexiteit plus
   192140302 Artificial Intelligence

In all other instances, the admissions board conducts a more detailed assessment of the applicant’s eligibility for admission. Consult the Teaching and Examination regulations (DER) for the exact requirements.

3.5.2 Traineeship

During the traineeship (external training) you apply your knowledge that you acquired in your master’s programme, working at a company or institution. The purpose is to work under circumstances resembling the situation after your graduation as much as possible. Included in this working experience is also the process of finding a position and a short application procedure. The traineeship has a study load of 20 EC and will last at least 14 weeks.

Organization

The following persons and organizations play a role during your traineeship:

- The host organization, which is the company or institution where you will carry out the traineeship. The host organization assigns a staff member who will supervise your work.
- The Educational Supervisor is a lecturer of your master’s programme. He/she will monitor the scientific level of your traineeship. The Educational Supervisor should give approval to the traineeship before you make your final appointments with the host organization. After the traineeship, he/she will carry out the final assessment and decide about the mark.
- The traineeship office, which consists of the traineeship coordinator and the mediator. They will supervise the student from the beginning of the searching process finding a position until the end of the traineeship, when the last documents should be archived.

Options for a traineeship

Most students usually find a traineeship position at a company, but also an institution or university is possible. A traineeship can be done everywhere in the world; in Enschede but also in New Zealand or somewhere in between. “The sky is the limit”, unless you manage to find a position with NASA or ESA as an astronaut. The only place on earth definitely out of scope is the UT itself. In all cases, the host institute should provide an assignment that must be approved by the educational supervisor. Approval will only be given if the assignment has sufficient academic level.
How to find a position

One might distinguish three ways to find a host institute:

1. The database of the traineeship office: the office maintains databases containing companies and experience reports. These reports are written by students and describe their experiences during the traineeship.
2. A lecturer in a chair (research group): during research, lecturers often cooperate with companies and institutions that might also be willing to provide a traineeship position.
3. On your own: it is possible and allowed to find a traineeship position on your own. Many companies offer traineeship positions on their websites. Finding a position in this way may not be easy but it may lead to a surprising and rewarding traineeship.

In all cases the traineeship must be approved by a lecturer before you make your final appointments with the host institute. This is described above.

Information sessions

Twice a year information sessions are held about the traineeship, in September and April. You can find them in the timetables of the master’s programmes.

First contact

Make an appointment with the traineeship mediator (stages@utwente.nl) if you start to think about a traineeship. During this meeting, the procedure will be discussed and a planning will be made for the preparation, the traineeship itself and the completion after return. See your mediator at least six months before you plan to go. After this meeting, the Blackboard site with training positions will be opened for you.

Web references

Static information: www.utwente.nl/en/education/external_training/
Blackboard site with training position database: blackboard.utwente.nl.

Traineeship Coördinator:
Dr. M.J. (Maarten) Korsten
Room: Zilverling 1022; Phone: +31 53 489 2779; E-mail: m.j.korsten@utwente.nl

Traineeship Mediator:
Mrs. B. (Belinda) Jaarsma
Room: Zilverling 1018; Phone: +31 53 489 3887; E-mail: b.jaarsma-knol@utwente.nl

3.5.3 Final project

1. Students complete graduation work (final project) worth 30 credits. For Trento Double degree students the following holds: if they are entry students (starting in Twente) they complete their graduation work in Trento; if they are exit students (starting in Trento) they complete their graduation work in Twente.
2. Graduation work consists of a graduation project, a graduation report, a summary of the report, and a presentation. Generally the Research topics above immediately precede the graduation work, and serve as a preparation for the graduation work.
3. Students may start graduation work only if they have completed all of the remaining components of the study programme.
4. Faculty chairs take responsibility for supervision and assessment of graduation work. For the M-HMi programme the chair responsible is HMI. For Trento Double Degree students the supervision is a joint effort by HMI and LMI.

The final project should enable the student to apply the expertise gained during prior courses, projects and practical training sessions to solve well-defined problems of sufficient academic difficulty. In completing the final project, students must be allowed to make their own decisions. Students must be able to address the problem systematically, achieve clear results and formulate clear conclusions. Students are expected to report, both orally and in writing, on their findings and read and process relevant literature critically. Students who choose the combined traineeship and final project may use part of their credits to focus on the project theme before leaving and work on their report after their return.

At the beginning of the final project, the student and the graduation supervisor make work agreements. The graduation supervisor ensures that the assignment is in line with the ‘mission’ of the student’s chosen specialization and arranges for adequate supervision. The student will meet with the supervisors regularly to discuss the progress of the final project. These meetings focus on both the content and the implementation of the final project (comparable to the job appraisal interviews students will encounter later in their career).

To complete the final project, the student must submit a written report and hold a public presentation. The report should also contain a text reflecting upon the relevance of the research work of the final project in the society.

The student contacts a chair willing to take responsibility for the development, organization and supervision of the project and/or an external organization where the project can be performed. The programme mentor can help find a chair. The chair can be of assistance in making arrangements with external organizations. The following conditions must be met prior to definitive admission to the final project:

• The programme mentor has approved the student’s course programme.
• A chair/chairs willing to take responsibility for the organization, supervision and assessment of the graduation project has/have been found.
• Outside of the final project or combined traineeship and final project, the student requires no more than 10 credits to be eligible for the master’s programme final assessment.

The programme mentor is responsible for ensuring that there is proper supervision and evaluation during the course of the final project.

3.5.4 Study Abroad

A student is allowed to study 30 credits externally. To gain international experience a student is given the chance to study abroad to another university or institute to follow courses or doing projects. The choice of courses or projects has to be approved by the programme mentor in the same way as the other part of the programme is approved.
3.6.3 Programme Mentor

The programme mentor is appointed by the Examination Board to advise students in their choices, and with the power to grant the approval of their course programme. Students can contact the programme mentor anytime to get advice on courses to take, internships, research topics or research assignments.

The programme mentor for the master’s programme Human Media Interaction is Dr. D. (Dirk) Heylen. You can find him in building Zilverling, room 2055; Phone: +31 53 489 3745; E-mail: d.k.j.heylen@utwente.nl.

3.6.4 Coordinator International Students

The coordinator for international students is Drs. J. (Jan) Schut. He can be contacted for any questions about the programme. You can find him in building Zilverling, room A108; Phone: +31 53 489 4350; E-mail: j.schut@utwente.nl.

3.6.5 Study Adviser

The study adviser supports students during (study) problems that they might encounter. Besides programme-related problems, students can contact the study adviser for questions about studying, planning, complaints, educational and examination regulations and your legal position. The study adviser is the confidant for students.

The study adviser for Human Media Interaction is T. H. (Thea) de Kluijver, MA. Building Zilverling, room 1003; Phone: +31 53 489 3697; E-mail: t.h.dekluijver@utwente.nl.
4 CHAIRS
4.1 COMPUTER ARCHITECTURE FOR EMBEDDED SYSTEMS (CAES)

Our mission is to perform research on energy-efficient dependable architectures for embedded systems. Our main focus is on streaming applications; applications that process streams of data like e.g. audio- and video streams, and that operate without changes for relatively long periods of time.

For streaming applications found in battery powered mobile devices (e.g. wireless sensor nodes and portable multimedia players) energy-efficiency is very important. But also for high-performance computers reducing power consumption is becoming more and more important. An interesting high-performance streaming application is medical image processing. For example: a surgeon needs in real-time X-ray images of the patient during surgery. Such an image processing pipeline has very stringent requirements, e.g. a fixed latency (no jitter) of 20 ms. Its our challenge to satisfy these requirement while at the same time, power consumption is reduced. Also signal processing for phased array antennas (for radar and radio astronomy) is part of our research.

Within the embedded systems domain we work on both the software and hardware side.

Concerning software, we develop tools to generate code for executing streaming applications on a multi-core platform. Furthermore, we work on Clash, a tool for generating hardware (VHDL code) from a specification written in a functional language.

Concerning hardware, we developed an energy efficient reconfigurable architecture called the Montium®, in cooperation with Recore Systems, a spin-off company of our group. In real life a Montium is a reptile that adapts to its environment like a Chameleon. Also our Montium processor is able to adapt to its environment.

In cooperation with Atmel, specialist in design and manufacture of advanced semiconductors, a reconfigurable multi-processor System-on-Chip (MPSoC) called the Annabelle was produced. It contains 4 reconfigurable Montium processors in CMOS technology (2 mm² per Montium). We also developed, together with recore systems, a 9 processor reconfigurable chip, the CRISP chip and a platform for processing in space.

In MPSoC systems for streaming applications, dependability (i.e. availability, reliability, integrity and maintainability) techniques play an important role. One of the problems in manufacturing a MPSoC with millions of transistors using deep-submicron technologies (90 nm and below), is an increase in the probability of defects in silicon, which results in decreasing manufacturing yield. We develop methods to deal effectively with the increased defect density for fault detection, localization, and fault tolerant architectures implemented on-chip.

Not only mobile devices can profit from energy efficient solutions. In cooperation with Alliander, RWE and Philips Research, we also work on optimization algorithms for smart buildings and smart grids.

Prof. dr. ir. G.J.M. Smit

4.2 DESIGN AND ANALYSIS OF COMMUNICATION SYSTEMS (DACS)

One of the first things I’ll do every morning, is to go to the living room and take a look at the screen of my Apple notebook. This screen not only gives the latest news, but also shows the radar pictures that predict whether and where rain will fall within the next few hours. Depending on these pictures, the decision is made whether I’ll go by bike, or by car to the UT.

Next to me, there are everyday millions of users worldwide that depend on infrastructures like the Internet and GSM/UMTS networks for making decisions. Although these infrastructures are continuously getting faster, the key challenge however is to make these infrastructures more reliable. The Design and Analysis of Communication Systems (DACS) group therefore focuses on dependable networked systems.

Research and education within DACS covers the whole spectrum of network technologies: from well-established technologies (like the wired Internet), via technologies that are under development (such as wireless networks) to emerging technologies (like embedded network systems).

In the case of well-established technologies, research concentrates on operational aspects, here, in particular, of the wired Internet. Specific topics include bandwidth allocation, accounting, self-management of lambda switches and protection against scans, denial-of-service attacks and phishing. Taking and interpreting measurements plays an important role in research. For technologies under development, research focuses on the design, evaluation, and prototype implementation of new protocols and algorithms for wireless and ad-hoc networks. Topics include algorithms for context- and power-aware routing in ad-hoc networks, and, lately, more and more on car-to-car communications and wireless sensor networks.

The research on embedded networking technologies focuses on system specification and evaluation techniques to describe such systems, and the resource constraints (performance, dependability, energy usage) they have to operate under. This includes the development of new stochastic model checking techniques and the application thereof to predict dependability and performance properties. Such models are applied, for example, to analyse control networks for critical infrastructures, such as the water and electricity networks.

Whenever possible, within DACS M.Sc. projects are part of bigger projects, facilitating close collaboration between M.Sc. and Ph.D. students. In the past this has resulted into several joint papers by M.Sc. and Ph.D. students, and presentations of these papers by M.Sc. students at international conferences.

Dr. ir. Aiko Pras
4.3 THE DATABASE GROUP (DB)

TO PROVIDE DATA MANAGEMENT TO CREATE ADDED VALUE
ON TOP OF AUTONOMOUS DATA SOURCES

Nowadays huge amounts of data are produced by both humans (“prosumers”) and devices connected to the Internet. This has led to information overload and a decrease in the trust of data (lack of quality, inaccuracy, ambiguity, and even inconsistency), as well as an increase of privacy threats. At the same time applications need data of high quality, and a way to deal with privacy sensitivity. Our approach is to extend database systems with data management functionality that filters and computes relevant information out of the data, reduces the unreliability of the data, and protects the privacy.

The core competence of the group is data management. On top of that, individual members of the group have expertise in database technology, information retrieval, security, XML, and streaming data. This combined expertise makes it possible to work on our mission. To address query processing and information retrieval meet. To deal with a lack of trust we work on enriching uncertain data, and finally to deal with privacy threats we work on Security and Privacy.

Search on semi-structured data

With the rise in application of XML technologies, the need arises for management of large collections of XML documents. Our research on querying and searching of semi-structured data aims to extend relational technology for processing XML data. The group primarily addresses XML query optimization and search and ranking. Future work will be on Large-scale distributed search, Social search for communities, and Spatial search.

Enriching uncertain data

Uncertain data can be found in many flavors. Data integration matches schemas and data of different sources, possibly leading to ambiguities and conflicts. Processing multi-media data introduces uncertainty, e.g. by the quality of feature extractors. The same applies for acquired sensor data, e.g. the location of a person acquired by a localization system. The processing, querying, and retrieval of extracted metadata must acknowledge uncertainty in the data. We investigate how to increase certainty by relaying uncertain data with additional knowledge from the context, application, and community knowledge, in particular pertaining to context aware systems, location based services, and multimedia retrieval. In the near future we intend to investigate data integration, entity matching/identification/resolution, streaming data processing specification, evolution and provenance, and data quality improvement with user & system feedback.

Security and Privacy

Work is done in the following areas: search in encrypted data, access control and privacy protection. Regarding search in encrypted data, we investigate the problem how personal, sensitive data can be securely stored on a (third party, attractive but) untrustworthy server. Regarding access control, we investigate how secret keys, stored by authorized users and used for cryptographic enforcement of access control mechanisms, can be distributed and managed. In the future we aim to address secure handling of healthcare data, and investigate amongst others key management and distribution in medical applications. Regarding privacy protection, our idea is to subject data to progressive degradation while preserving the intended usability of the data. Progressive degradation is a refinement of limited retention (an “all-or-nothing” approach). We want to show that data degradation is practically feasible.

More information about the Database group can be found at: www.utwente.nl/ewi/db

Prof.dr. P.M.G. Apers

4.4 DISTRIBUTED AND EMBEDDED SECURITY (DIES)

Security and protection of privacy in ICT systems becomes more and more important in a world of networked devices that pervade our lives to an ever larger degree. Examples are Industrial Control Systems where computers monitor and control critical processes in factories and plants, modern smartphones that we use continuously update our digital representation in social networks like Facebook, or modern vehicles which are complex networks of dozens of embedded computers that communicate more and more, and also with the external world.

Failing to take security and privacy protection into account in the design, implementation, and evaluation of such systems can have disastrous effects. Loss of personal data and credit cards from online platforms, cyber attacks on companies, or infection of computers by malware are already ubiquitous. Addressing the security and privacy challenges is becoming a top priority in many of these areas and this is what the research and teaching of the Distributed and Embedded Security group (DIES) focus on.

As we work on the analysis, design and evaluation of distributed and embedded systems security, we face the complex, heterogeneous, networked systems that operate in often hostile environments, often under severe resource constraints. Security research spans a broad range, starting from both lowest level of a computer and operating system and from cryptographic and mathematical foundations all the way up to applications, user behaviour, or embedding of our security mechanisms into the real-world environment that these systems operate under.

Applied methodologies also have to reflect this broadness in scope. Mathematical tools, formal modelling and model-based verification form one group of mechanisms that we use in our daily work. They go alongside practical investigations and implementation of functional prototypes. But also the use of complex simulations to evaluate large and complex systems is applied regularly. And then, security research is often also a game of cat and mouse, where attackers will only need to find one weakness in a design to completely break the security of the system. Protecting from attacks thus demands thorough, careful, and robust system design, a skill that is highly appreciated not only in security.

Our teaching also reflects the broad range of topics. We teach basic courses on cryptography, operating systems, and introduction to security at the bachelor level, followed by more specialized master courses, for example on security and privacy of mobile systems or the prevention of cybercrime. We also train students
in ethical hacking and offer exciting opportunities for individual research work on the topics described above, for example in the form of a master thesis.

One of the strengths of Dies is that it hosts researchers with a complementary set of expertise that enables us to perform security and privacy research starting from a strong theoretical and mathematical foundation but also covering system-oriented research as well as many specific applications domains like health, wireless sensor networks, social networks, and the automotive and transportation domain. Close ties with other groups that focus on specific aspects like Information Systems, Databases, or Communication Systems complements the picture.

We believe that a close integration of teaching and research is a fundamental principle of a University. Master students working with Dies are therefore often working in the context of bigger projects and also collaborate with PhD students and external partners in such projects. This includes the Dutch police, car manufacturers like Volkswagen or Daimler, and IT companies like NXP. This also offers interesting job perspectives after your studies at UT have ended.

We also have students involved in practical testing of the security mechanisms of the university network or participating in international hacking contests like the international Capture The Flag contest where they compete with dozens of other teams around the world.

Students also regularly contribute to scientific papers, maybe creating the first entries to a publication list of a long and successful academic career. No matter whether you see your personal goal in an academic career. No matter whether you see your personal goal in an academic career, our motivation is to educate the top security specialists that have the necessary skill and knowledge to solve the security and privacy problems of the future.

prof. dr. P.H. Hartel

4.5 FORMAL METHODS AND TOOLS (FMT)

‘THE QUEST FOR CORRECTNESS’

All human endeavor is imperfect. But software bugs are extremely annoying, costly, or even dangerous. Desktop computers can simply be restarted if they reach a blue screen; buggy TV’s and remote controls can still be recollected by their manufacturers. For aviation software, railway controllers, nuclear power plants and medical equipment, failing systems are simply unacceptable. Can we avoid errors at all, or should we tolerate them? What are effective methods to spot errors? Is it possible to prove the absence of error?

Software correctness

The research and education of the Formal Methods and Tools group aims at applying rigorous techniques to improve the quality of software-intensive systems by all means. To avoid errors, requirements specifications and early designs are scrutinized with powerful tools, such as model checkers and theorem provers. On the other side of the development lifecycle, an emerging field is software verification at the level of source code or the generated byte-code. Even further down the line, an effective method to detect bugs is by applying systematic testing techniques. An important goal is to learn which method is most effective in some phase of the software life cycle. Of course this depends on the type of system and the particular aspect that one wants to study, e.g. correctness, security, timing, dependability. For embedded systems, quantitative and hybrid aspects come into play as well.

Theory

There’s nothing more practical than a good theory. The theory behind software verification stems from discrete mathematics and logic. These fields provide us with the reasoning capabilities to prove beyond all doubt that a system is correct, or to establish coverage criteria of test suites. Nasty errors typically arise from interactions between concurrent subsystems. Therefore, concurrency theory is a fundamental background for our research and teaching. Central themes are process algebra, (timed/hybrid) automata, and temporal logics. Also algorithmic game theory provides fundamental insights in interacting systems (players) and environments (the adversary).

Tools

Software verification is really challenging from a computational point of view. The devil is in the details. Our tools should analyze all possible scenarios. However, there are exponentially many! So the tools that we build contain non-trivial data structures (such as binary decision diagrams), complicated algorithms (e.g. symmetry reduction) and clever implementation techniques (incremental hashing). We are also constructing parallel algorithms for clusters of workstations and multi-core machines, to tackle large problem instances by brute-force hardware solutions. It is an engineering challenge to combine all these ingredients effectively!

Interested?

We offer broad courses for students in Software Engineering and Embedded Systems. These are aimed at modeling notations, and the effective usage of verification tools. Become a verification engineer!

For the theoretically inclined, we offer the track MTv. Modeling and Tools for Verification. The specialized courses aim at understanding and extending the theory and algorithms behind the tools, and form an excellent background to become a researcher in this field. FMT is coordinating the graduate school programme ‘Dependable and Secure Computing’. We also offer exciting projects for both theoretically and practically oriented students.

Prof. dr. J.C. van de Pol
4.6 HUMAN MEDIA INTERACTION (HMI)

“COMPUTING POWER AND THE FABRICS OF EVERYDAY LIFE”

“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.” This is a famous quotation from a paper called “The Computer for the 21st Century” written by Mark Weiser.

Computer technology that weaves itself into the fabric of everyday life. This is also the vision of the Human Media Interaction group whose goal is to realize this idea of invisible computing technology. In his view the fabric of future everyday life includes what we now see around us: other people, animals, furniture, clothes, walls, and devices that support us and our children in our daily home, recreational, office, and mobile activities. But in this fabric we will have intelligent sensors that detect what we are doing, share knowledge amongst themselves, and interpret what is going on. In addition to this ‘invisible’ intelligence embedded in the environment we will have human-like robots and also virtual humans displayed in virtual and mixed reality environments that interact with their human partners in humanlike ways.

Home and other environments, humanoids, and devices that see, hear, and feel what we are doing will become familiar with us. They will know about our background and history, they will know about our preferences, our moods and emotions, and they will therefore be able to anticipate what we want. Hence, we enter the area of artificial intelligence and of affective and empathic computing. That is, computers embedded in environments, furniture, pets and physical and virtual and robot humanoids that display rational and social intelligence, and that show empathy.

Sensor-equipped environments allow implicit and explicit interaction. We have implicit interaction if the environment understands and anticipates our actions and activities. Anomalies of daily activities can be detected and the environment and its devices may decide to inform or ask the inhabitant about what is going on, it may autonomously take action to repair or recover from a certain situation or it may issue a warning to a monitoring system. Recommender systems may suggest activities or commands based on preferences of inhabitants of smart environments.

Human Media Interaction research is multi-disciplinary research. Traditional computer science research is of course important. We need to design and implement interfaces, whether they are invisible or not. In particular this design should address the issue of ‘natural interaction’ for the human user. That is, we need to look at verbal and nonverbal behavior of humans when they interact with each other, their children, and their pets. We should understand what roles are played by gaze, head orientation, gestures, posture, and verbal interaction and these roles should also be modeled in order to embed similar capabilities into synthesized environments and humanoids. Clearly, as human media interaction researchers, for that we need to cooperate with scientists from behavioral sciences. We need to cooperate with cognitive scientists about mental activities of inhabitants of our future smart environments. And we need to cooperate with (social) psychologists about designing environments and humanoids that can show empathy and that allow the emergence of social relationships between humans and their ‘artificial’ partners.

Prof. Dr. Vanessa Evers and Prof. Dr. Dirk Heylen

4.7 INFORMATION SYSTEMS (IS)

“Value creation for organisations requires new information system architectures. Commercial and public organisations no longer view information technology only as a way to save costs in their processes, but also as a resource to create additional value. According to prof. dr. Roel Wieringa, chair of the Information Systems Group, this ‘calls for new architectural designs in the information function of organisations.”

“This phenomenon started in the 1980s with the advent of EDI networks, accelerated in the 1990s with the proliferation of the Internet, and today is widespread across the globe. This calls for continuous rethinking of business process and information technology effectiveness in value creation. Often these value networks are decentralized, meaning that they consist of equal partners, without a central authority. Information systems therefore need to be designed in accordance with the goals of a disparate set of independent stakeholders. In this context, information systems should support processes within and across organizations that may or may not be fully specified. And at the same time, they should avoid harm to security and privacy of the actors involved. Our mission is to develop methods, concepts, and tools for the efficient and effective design of information systems in decentralized networks, and to provide bachelor- and master-level teaching in these areas. We also take responsibility in transferring the results of our research to society.”

“We have three kinds of research projects. In a number of projects we work with companies to develop tools and techniques for value web creation, that is, the creation of networks of profit-and loss responsible partners. For example, we work with companies in the music business and in the electricity supply business to redesign their value webs, redesign their cooperation processes, and redesign their IT architecture to enable working on a pay-per-use basis. In a second group of projects we develop mobile and context-aware technology that provides improved or value-added services to clients in health care organizations. In a third group of projects we develop information risk assessment tools and techniques for companies that work in a value web, and that need to assess the risks of compromising their information systems. We work with financial companies, organizations in health care, consultancy companies, manufacturing companies and with government organizations. We take care that in our research we follow sound methodological principles, as well as that we produce results that are relevant for society.”

Prof. dr. R.J. Wieringa
4.8 THE PERVERSIVE SYSTEMS GROUP (PS)

The Pervasive Systems group investigates a new paradigm for bringing the flexibility of information technology to bear in every aspect of daily life. It foresees that people will be surrounded by embedded and flexibly (wirelessly) networked systems that provide easily accessible yet unobtrusive support for an open-ended range of activities, to enrich daily life and to increase productivity at work.

Imagine a world with smart machines that can self-diagnose and repair, predict aging components and proactively alert factories for replacement parts before the machine breaks down. Smart roads will make travel safer and highways less congested by noting accidents, potholes, alternate routes and reporting the information to a car’s global positioning system. Smart appliances, such as heaters, will understand families wishes and take measures to have optimal comfort and the lowest price.

The work of Pervasive Systems will help to realize this vision.

Sensors are tiny devices capable of capturing physical information, such as heat, light or motion, about an environment. Rapid advances in technology have enabled a new generation of tiny, inexpensive, networked sensors. Embedding millions of sensors into an environment creates a digital skin or wireless network of sensors, each sensor capable of capturing physical information about its immediate space. These massively distributed sensor networks communicate with one another and summarize the immense amounts of low-level information to produce data representative of the overall environment. Collaborative, smart sensor networks present information in a qualitative, human-interpretable form, which allows people (or computers) to respond intelligently. Sensor networks will change the way we work and live.

The research of the Pervasive Systems group incorporates both system software and networked embedded systems, and evaluates this in a suitable application context. To do so, we address the following stages:

- Observe: sensing, distributed monitoring, pervasive data management;
- Learn and adapt: reasoning, intelligence;
- Control and feedback: give adequate interaction to the system and the persons.

In the Pervasive Systems group we address the corresponding research aspects in the following domains:

**Health and sport**
How to improve the performance of a sporter? How to make elderly people stay safely at home longer? How to improve the rehabilitation process of a COPD patient? All such questions we address through the use of wearable computing, in which activity monitoring and recognition, coupled with real-time feedback to the persons is one of the enabling methodologies.

**Sustainability and environmental monitoring**
How to ensure that we will be able to live comfortably in a clean environment? How can we address climate changes, and evaluate the effects on the Great Barrier Reef or the Waddenzee? How to make an energy-efficient building? Biodiversity in and around urban areas are under great pressure through growing urbanization and transport infrastructures. In this research line we design methodologies to monitor and analyze long-term changes in the environment, and detect changes and anomalies.

**Smart Cities and Intelligent transport systems**

How to keep monitor the effects of tunnel drilling on the houses in Amsterdam? How to keep a close look at the structural health of historical buildings in Rome? How to monitor the safety of a bridge? Structural health monitoring of buildings, bridges, tunnels and other structures is estimating the state of structural health, or detecting the changes in structure that influence its performance.

Wireless sensor networks enable dense in-situ sensing and simplify deployment of instrumentation. In this research line we address QoS-aware data aggregation and situational awareness through online distributed outlier and event detection in linear topological networks.

**Interested to participate in this research?**
We offer a range of courses in this domain, and have a wide variety of challenging master assignments in which you will be able to work to results that matter. The research performed are mostly part of national and international projects, in which PhD and M.Sc students collaborate whenever possible. On our website ps.ewi.utwente.nl more information can be found on our group and research activities.

Prof. dr. P. Havinga

4.9 SOFTWARE ENGINEERING (SE)

‘DESIGNING AND MAINTAINING LARGE AND COMPLEX SOFTWARE SYSTEMS’

Software is everywhere; in your TV, music set, mobile phone, camera, car, banking system, and even in your electrical tooth brush. Software rules the world; nobody can imagine the world without software. Since software is affecting our lives in so many ways, it is important to maintain it at a high level of quality. But software is becoming increasingly large and complex, for instance, millions of lines of code are necessary already for your modern TV. With increasing code size, the structure of software does matter for its survival. You need to know how to build and deal with complex and large software systems in order to ensure correct...
behavior and to enable the addition of new features in the future. Thus, the Software Engineering group focuses on Quality-Oriented Software Engineering. Our mission is:

‘To model, implement and optimize software engineering processes for specifying, designing, implementing, verifying and optimizing software artifacts at various abstraction levels for the purpose of fulfilling the stakeholders’ requirements of software systems’.

To ensure a good quality of software, you need to shape it well. All relevant concerns must be separated from each other and their implementation must be as independent as possible, e.g., contained in different files. If you perform this so-called decomposition of your software wrongly, it will become useless sooner than you expected. A good decomposition can make software resilient to downsides of life, able to recover from crashes, run fast, and adaptable to unforeseen conditions.

The Software Engineering group carries out research projects with a number of industrial partners to deal with huge software systems. We investigate means to shape software optimally so that your smart home and web services keep on working as expected. We research means enabling software to recover from crashes so that, for instance, your TV keeps on showing your favorite channel, in real time. To keep, e.g., your printer functioning optimally, we search for methods making software adaptable to changing conditions. We develop methods to realize systems that can smoothly evolve, for example to have shorter times-to-market for new advances in medical equipment.

The Software Engineering group has structured its research activities in complementary and partially overlapping research areas, identified by considering abstraction levels (from programming to architectures), application domains (from embedded to distributed (large-scale) systems), and relevant quality factors and supporting techniques. These areas have also been identified taking into consideration the expertise and interest of the scientific staff, and have allowed the group to acquire national and international projects. The research areas are: Programming Languages, Architecture Design, Service Architectures, Verification and Optimization. The quality factors addressed by the group are, amongst others, compositionality, correctness, dependability, evolvability, traceability, open-endedness and flexibility.

Our master education program in software engineering covers the state-of-the-art topics necessary to design and maintain high quality software systems. Once you graduate, chances are that you will work as a software engineer, like many of our graduates. Every graduate can write some software. No problem with that. But most importantly, do you know how to design and build successful software systems that will have the right balance of the desired qualities?

Prof. dr. ir. Mehmet Aksit
5 COURSE OVERVIEW
### 5.1 COURSE OVERVIEW

**DEPARTMENT OF COMPUTER SCIENCE**

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5.2 COURSE OVERVIEW
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<td>Integrated Circuits and Systems for Mixed Signals</td>
<td>5</td>
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<td>191210900</td>
<td>Introduction to Biometrics</td>
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<td>191210901</td>
<td>Introduction to Biometrics</td>
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<tr>
<td>191210740</td>
<td>Material Science</td>
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<tr>
<td>191210780</td>
<td>Modern Communication Systems</td>
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<td>191211080</td>
<td>Systems Engineering</td>
<td>5</td>
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<tr>
<td>191211590</td>
<td>Systems-on-Chip for Embedded Systems</td>
<td>5</td>
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<tr>
<td>191211310</td>
<td>Technology for the Support of Human Functions</td>
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<td>Digital Control Engineering</td>
<td>5</td>
<td>1A+1B</td>
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<tr>
<td>191210930</td>
<td>Measurement Systems for Mechatronics</td>
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<td>1A+1B</td>
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<tr>
<td>191211100</td>
<td>Mechatronic Design of Motion Systems</td>
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<tr>
<td>191210750</td>
<td>System-on-Chip Design</td>
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<tr>
<td>191211720</td>
<td>Microwave Techniques</td>
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<td>1B</td>
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<tr>
<td>191210860</td>
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<td>Technology</td>
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<td>1B</td>
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<tr>
<td>191211710</td>
<td>Core Networks</td>
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<td>Advanced Analog IC Electronics</td>
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<td>191210441</td>
<td>Control Engineering</td>
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<tr>
<td>191211140</td>
<td>Electrophysiologic Signals and Bio-Electricity</td>
<td>5</td>
<td>2A</td>
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<tr>
<td>191210431</td>
<td>Engineering System Dynamics</td>
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<tr>
<td>201000237</td>
<td>HalfgeleiderDevices</td>
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<td>2A</td>
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<td>191211470</td>
<td>Home Care Technology</td>
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<td>191210910</td>
<td>Image Processing and Computer Vision</td>
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<td>2A</td>
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<td>2A</td>
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<td>191210880</td>
<td>Integrated Optics</td>
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<td>191210820</td>
<td>Materials for Information Storage</td>
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<td>2A</td>
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<tr>
<td>191211450</td>
<td>Measurement and Signal Analysis</td>
<td>4</td>
<td>2A</td>
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<tr>
<td>191211300</td>
<td>Micro Electro Mechanical Systems Design</td>
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<td>2A</td>
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191211130  Neurotechnology       5  2A
201000235  Random Signalen en Ruis 5  2A
191211320  Testable Design and Test of Integrated Systems 5  2A
191210790  Transmission Media     5  2A
191210840  A/D Converters         5  2B
191210940  Advanced Digital Signal Processing 5  2B
191211330  Digital Electronic Circuit Design for SoC 5  2B
191211400  Electromagnetic Compatibility 5  2B
201000236  Inleiding Communicatiesystemen 5  2B
191211120  Lab on a Chip           5  2B
191211030  Mobile Radio Communications 5  2B
191211060  Modern Robotics         5  2B
191211650  Multi-Disciplinary Design Project 10  2B
191210601  Optical Basic Functions and Microsystems 5  2B
191210920  Optimal Estimation in Dynamic Systems 5  2B
191211090  Real-Time Software Development 5  2B
191211500  Wireless Transceiver Electronics 5  2B
191211279  Activity in the Social and Managerial Field 5  JAAR
191210860  Advanced Electronics Project 5  JAAR
191211000  Advanced Semiconductor Devices 5  JAAR
191211249  Experimental Work       5  JAAR
191211559  Individual Project      15 JAAR
191211208  Industrial/external Training 20 JAAR
191211229  Literature Study        5  JAAR
191211219  Master Thesis Project   40 JAAR
191211689  Research Project for Exchange Students 0  JAAR
191211239  Take Part in a Studygroup 5  JAAR
201200122  Algorithms for Model Checking 5  1A
192130240  Embedded Computer Architectures 1 5  1A
192130250  Embedded Computer Architectures 2 5  1B
191210001  Instrumentation for Embedded Systems 5  1B
201200006  Quantitative Evaluation of Embedded Systems 5  1B
201000231  Computer Arithmetic      5  2A
201000232  Knowledge Based Control Systems 4  2A
201000230  Multiprocessors          5  2A+2B
201000168  Embedded Systems Laboratory 5  2B
191211749  Individual Project      10 JAAR

For a more up to date overview of all Computer Science and Electrical Engineering courses go to the corresponding programme websites. Course content/specifics are available on www.utwente.nl/coursecatalogue.
1 THE FACULTY OF EEMCS

The Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS) comprises three disciplines, each of which again has connections with other disciplines. Besides teaching, research is carried out in the faculties by our research groups/chairs. This research is entirely clustered in the university research institutes Institute for Nanotechnology (MESA+), the Centre for Telematics and Information Technology (CTIT) and MIRA.

1.1 Organization chart EEMCS

Dean
Dean of the faculty of EEMCS is prof.dr.ir. Ton Mouthaan. With him rests ultimate responsibility for all of the faculty’s educational programmes.

Faculty Council EEMCS
The Faculty Council EEMCS is a representative advisory body of the faculty. The Council consists of eight students and eight staff members. The students are elected annually, the staff members serve on the Faculty Council for a period of two years. Nominations for the Council take place in April, the elections are held in June. The Council’s term of office runs parallel to the academic year.

Depending on the subject at hand, the Faculty Council has advisory powers or the right of consent about the proposed decisions of the faculty dean. If he wants to take decisions about the outlines of personnel policy, regulations in the field of terms of employment and the occupational health and safety policy, the dean requires the consent of the Faculty Council beforehand. The dean also requires the Faculty Council’s consent beforehand if he wants to take decisions on setting or modifying the faculty Education and Examination Regulation (OER), rules in the field of safety, health and well-being or policy on students’ facilities.

For more information concerning the Faculty Council, please refer to: www.utwente.nl/ewi/organisatie/bestuur/faculteitsraad (Dutch)

The Board of Professors
The Board of Professors consists of all professors and programme directors of the faculty.

1.2 Educational programmes

The faculty offers the following educational programmes:

Bachelor’s programmes:
- Electrical Engineering (EE)
- Technische Informatica (INF)
- Technische Wiskunde (TW)
- Creative Technology (CreaTe)

Master’s programmes:
- Applied Mathematics (AM)
- Computer Science (CSC)
- Electrical Engineering (EE)
- Embedded Systems (EMSYS) (3-TU)
- Human Media Interaction (HMI)
- Systems and Control (SC) (3-TU)
- Telematics (MTE)

Programme director
At the head of every educational programme is a programme director. He marks the outlines of the educational programme and is responsible for the content of the educational programme and its courses.

- For EE (BSc and MSc) this is prof.dr. M.C. Elwenspoek (Miko)
- For TW, AM and SC this is dr. J.W. Polderman (Jan Willem)
- For INF, CSC and MTE this is dr.ir. R. Langerak (Rom)
- For CreaTe en HMI this is dr. G.F. van der Hoeven (Gerrit)
- For EMSYS this is prof.dr.ir. G.J.M. Smit (Gerard)
1.3 Services and units

The faculty has a number of EEMCS-wide service groups which are under the direction of the director of operations, dr.ir. J.F.C. Verberne.

SAFETY AND HEALTH CARE EEMCS

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Phone number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinator</td>
<td>ing. S. Visser (Sjoerd)</td>
<td>+31 53 489 3153</td>
</tr>
<tr>
<td></td>
<td>ir. F. Houweling (Frans)</td>
<td>+31 53 489 3583</td>
</tr>
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</table>

OFFICE OF THE DEAN OF THE FACULTY OF EEMCS (BFD-EEMCS)

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>General e-mail address</td>
<td><a href="mailto:BFD_ewi@ewi.utwente.nl">BFD_ewi@ewi.utwente.nl</a></td>
<td></td>
</tr>
<tr>
<td>Dean</td>
<td>prof. dr.ir. A.J. Mouthaan (Ton)</td>
<td></td>
</tr>
<tr>
<td>Director of Operations</td>
<td>dr.ir. J.F.C Verberne.</td>
<td></td>
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</tbody>
</table>

Faculty secretariat

director of operations and MT

dean

EDUCATION SUPPORT OFFICE EEMCS (BOB-EEMCS)

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
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</tr>
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<tbody>
<tr>
<td>Manager of Education</td>
<td>H.J. van Laar (Jolanda)</td>
<td>+31 53 489 4466</td>
</tr>
<tr>
<td>Internationalization</td>
<td>drs. J. Schut (Jan)</td>
<td>+31 53 489 4350</td>
</tr>
<tr>
<td>Quality assurance</td>
<td>drs. J.H. Romkema (Hans)</td>
<td>+31 53 489 2774</td>
</tr>
<tr>
<td>Educational support</td>
<td>drs. K.M.J. Slotman (Karin)</td>
<td>+31 53 489 5809</td>
</tr>
<tr>
<td>Traineeship</td>
<td>dr. M.J. Korsten (Maarten)</td>
<td>+31 53 489 3887</td>
</tr>
<tr>
<td>Traineeship mediator</td>
<td>B. Jaarsma-Knol (Belinda)</td>
<td>+31 53 489 3887</td>
</tr>
<tr>
<td>Coordinator New Educational Model</td>
<td>dr.ir. E.J. Faber (Erik)</td>
<td>+31 53 489 2041</td>
</tr>
<tr>
<td>BSc Electrical Engineering</td>
<td>drs. J.A. Kamphuis (Jan)</td>
<td>+31 53 489 2771</td>
</tr>
<tr>
<td>Student advisers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSc INF and TEL</td>
<td>S.B.A.M. Vonk MSc (Sharon)</td>
<td>+31 53 489 5645</td>
</tr>
<tr>
<td>BSc TW and MSc CSC, MTE, AM</td>
<td>L. Spijler (Lilian)</td>
<td>+31 53 489 3493</td>
</tr>
<tr>
<td>BSc CreatE and EE, and</td>
<td></td>
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</tr>
<tr>
<td>MSc HMI, SC, EMSYS and EE</td>
<td>T.H. de Kluijver MA (Thea)</td>
<td>+31 53 489 3697</td>
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<td>Secretariat</td>
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<tr>
<td>Student advisers,</td>
<td>R. Assink (Remke)</td>
<td>+31 53 489 3426</td>
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<tr>
<td>Internationalization</td>
<td></td>
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<tr>
<td>Quality assurance</td>
<td>A. de Bruin-van Willigen (Annemiek)</td>
<td>+31 53 489 3725</td>
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<tr>
<td>Programme directors</td>
<td>K. Veldhuis (Karin)</td>
<td>+31 53 489 5450</td>
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COMMUNICATIONS

Communications is a shared service directorate within the UT. The following contacts apply for the faculty of EEMCS:

<table>
<thead>
<tr>
<th>Position</th>
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<tbody>
<tr>
<td>Communications staff member</td>
<td>D. Dalenoord (Diana)</td>
<td>+31 53 489 3450</td>
</tr>
</tbody>
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PREMISES MANAGEMENT

<table>
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<tr>
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<tbody>
<tr>
<td>Premises Manager</td>
<td>ir. M.J.B. ten Bulte (Michel)</td>
<td>+31 54 489 2800</td>
</tr>
<tr>
<td>Service desk</td>
<td><a href="mailto:Servicedesk.carre@fb.utwente.nl">Servicedesk.carre@fb.utwente.nl</a></td>
<td>+31 54 489 2299</td>
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LIBRARY & ARCHIVE

Library & Archive is a service of the University Library of the University of Twente.

<table>
<thead>
<tr>
<th>Position</th>
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<tbody>
<tr>
<td>Information Specialist</td>
<td>Mrs drs. P. de Willigen (Petri)</td>
<td>+31 53 489 2085</td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>ir. W.C. Oosterling (Wim)</td>
<td>+31 53 489 2079</td>
</tr>
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FACILITY SERVICE CENTRE

The Facility Service Centre is a shared service centre that offers its services within and for the various faculties, including EEMCS.

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Phone number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service desk</td>
<td><a href="mailto:Servicedesk.carre@fb.utwente.nl">Servicedesk.carre@fb.utwente.nl</a></td>
<td>+31 54 489 2299</td>
</tr>
<tr>
<td>Building contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citadel</td>
<td>N.C.M. Heijnekamp (Nancy)</td>
<td>+31 53 489 5768</td>
</tr>
<tr>
<td>Zilverling, Carré</td>
<td>T.B.M. Busscher</td>
<td>+31 53 489 6284</td>
</tr>
<tr>
<td>Account EWI</td>
<td>N. Kloek (Nico)</td>
<td>+31 53 489 6251</td>
</tr>
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</table>

ICT SERVICE CENTRE (ICTS)

ICTS is a shared service centre within the University of Twente. The following contacts apply for the faculty of EEMCS.

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
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<tbody>
<tr>
<td>Account Manager EEMCS</td>
<td>ing. A.B. Tibben (Tonnie)</td>
<td>+31 53 489 3724</td>
</tr>
<tr>
<td>ICTS Service desk</td>
<td><a href="mailto:icts.servicedesk@utwente.nl">icts.servicedesk@utwente.nl</a></td>
<td>+31 53 489 5577</td>
</tr>
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</table>
experiencing. This lab is, as it were, a meeting point where every possible research set-up is imaginable.

Educafe

Next to the (main) entrance of the Zilverling building, you will find the Educafe: a space where you can study, work in groups and relax with your fellow students. There are computer workspaces and you can grab a drink or snack from the vending machines. In short: this is an ideal environment to work together on projects. In the Educafe there are two rooms for get-togethers where students frequently sit around. On the first floor, three EEMCS student associations are situated: Scintilla (Electrical Engineering), Abacus (Applied Mathematics) and inter-actief (computer science). The student association for create, proto, has its room in Zilverling/Hal A, above the smart XP.

The Educafe also hosts two shops: IAPC and Stores. IAPC is a non-profit shop where you can turn to when you have questions about or want information on computers. Besides, you can buy laptops and all sorts of computer parts there for reasonable prices. Stores sells components (such as resistors and capacitors) and office supplies. Furthermore, IAPC as well as Stores sells study books. Both shops are run entirely by volunteers and they are open during weekday lunch breaks for most of the year.

1.4 Facilities

PC Rooms

For practical courses the faculty of EEMCS has a number of PC-rooms available. The W-zaal (West-room) situated in Zilverling/Hal A is mainly scheduled for Electrical Engineering practicals. Situated in Zilverling/Hal A as well is a general practical space, the flex office of Smart XP. Furthermore, there is a general computer room on the fourth floor of the Zilverling building (ZI 4054) which has 36 PCs. During lecture hours a room assistant is present in room 4054. At night this room is open until 20.30h. After 18.00h, you can obtain entrance via the night porter at the main entrance of the Zilverling building.

Please note that there are staff rooms situated near the course rooms in the Zilverling. So please keep quiet in the building corridors, limit talking and do not use your phone, but go to the stairwell or the Educafe instead. Eating is prohibited in the PC-rooms; drinking is only allowed when using lockable bottles.

Year Rooms

For first-year Bachelor students of the Mathematics, Electrical Engineering and Creative Technology programmes, year rooms are used for most classes will take place there. Instead of moving groups of students between lecture rooms, teachers will come to the one room dedicated to one of the programmes. Outside lecture hours this room can be used for self-study or as a project space.

BSc Mathematics (TW)  Citadel T100
BSc Electrical Engineering (EE)  Oosthorst 210
BSc Creative Technology 1st year  Smart XP
BSc Creative Technology 2nd year  Zilverling 3042
BSc Creative Technology 3rd year  Zilverling 2042

Smart XP Lab

This new multifunctional area in the Zilverling building is structurally used for teaching purposes towards the CreaTe programme. The lab is a true research playground and offers ample opportunity for testing and
2 THE ORGANIZATION OF EDUCATION

2.1 Students’ Charter
As every institute for higher education in the Netherlands, the University of Twente also holds a Students’ Charter. The Students’ Charter is legally based in art. 7.58 of the Dutch Higher Education and Research Act (WHW). The Dutch text of the Students’ Charter is law-making. This means that in case of problems or conflicts you can appeal to the content of the Dutch text of the Students’ Charter (or Studentenstatuut). The Students’ Charter contains a programme-specific section (the OSS) and an institute-specific section. The institute-specific section of the Charter is at all times available in its most up-to-date form on the website www.utwente.nl/so/studentenbegeleiding/en/regulations/charter.

If you would like to have a printed version of the Charter, it is available on request from the Red Desk: the information desk of the Student Counselling Service.

A copy of the programme-specific section of the Charter (OSS), which contains the Education and Examination Regulation (OER), can be collected from Bureau Onderwijszaken (BOZ). The programme-specific section contains at least:

- a description of the structure of the programme and the supporting facilities the institute offers to the students, including in any case (for definitions, please refer to the programme-specific section in question of the Charter):
  - information about the set-up, organization and realization of education,
  - the student facilities, and
  - the facilities concerning tutoring,

- the Education and Examination Regulation (OER)

- a description of procedures aimed at protecting the rights of students, which apply to the programme, in addition to the procedures that are established by the institutional administration.

www.utwente.nl/ewi/en/education/oer

2.2 Student Enrolment/Re-enrolment
Each academic year you are required to re-enrol at the University of Twente using Studielink. This re-enrolment is grafted on to the regulations in the Dutch Higher Education and Research Act (WHW) and it must be completed before 1 September. As soon as your request for re-enrolment via Studielink is received by the Central Student Administration (CSA), it will be verified whether you satisfy the conditions for enrolment. If you qualify for enrolment, your enrolment will be completed as soon as all enrolment documents have been submitted and the payment of your tuition fees is processed. To enrol or reenrol before 1 September, you must complete all enrolment formalities before 1 August.

When your enrolment is complete, as proof of enrolment you will receive your student card and two declarations of enrolment. The declaration contains, among other things, the programme(s) and the period for which you are enrolled.

On the university level there are various student service centres, which are united in the Student & Education Service Centre (S&O). The student desk accommodates the service centres. The main services are mentioned below

2.3 Studenten en Onderwijs (S&O)

Student Services
Student Services offers various support services: you can go there to have your digital picture taken for your student card, to register, enrol or de-enrol. Student Services is situated in the Vrijhof building. See also: www.utwente.nl/so/studentenservices/en/

Student Counselling Service
The desk of the Student Counselling Service (the “Rode Balie”) is responsible for individual care and support of UT students at a coordinating level (besides the care educational programmes take for their “own” students). This includes for example a student psychologist, various courses (“self management”, graduating, job application) and the student counsellor.

Student Psychologist
You can get help from the student psychologist when you need to talk to someone, for instance when you experience personal problems such as problems in your relation with your parents, friends or fellow students. You do not need a referral: you can make an appointment yourself. The student psychology service aims at having the first session within a week after the student contacted them.

Student Counsellor
The student counsellor offers help when you have questions about, for instance, student grants, UT financial support, switching disciplines, problems involved with switching from a school for Higher Vocational Education to University, personal problems, appeal procedures, studying abroad, studying with a disability, and entrance examination (colloquium doctum). In order to make an appointment you need to telephone the secretariat. You have to take the initiative yourself to make an appointment with the student counsellor. At certain times the student counsellor does consultations without appointment, for which you do not have to make an appointment in advance.

The “Rode Balie” is situated in the Bastille building. For more information, go to: www.utwente.nl/so/studentenbegeleiding/en/

Complaints Desk
As from 1 April 2011 the UT arranged for a so-called Complaints Desk. Any student or external student, including prospective and former students, can turn to the Complaints Desk with a formal complaint, a formal appeal, or a formal objection. The Complaints Desk is situated with Student Services on the second floor of the Vrijhof building.

You will find more information about the Counter and the complaints procedures on: www.utwente.nl/so/studentenservices/en/complaints_desk
2.4 Communication and Information

When you want to take up a study at the University of Twente, from the very start you will be faced with various means of communication the university, the faculty and your programme use to communicate with you. As soon as your preliminary enrolment at the University of Twente is received, you will be provided with an e-mail account, user name and password. You will also be provided with some writing space of your own, where you can save your documents and where you might put your own home page. The Internet is by far the most important means of communication of the programme and the university.

E-mail

Whenever the programme or a particular lecturer wants to communicate quickly with a particular student or a small group of students, this will be done by e-mail. The Student & Education Service Centre (S&O) also uses e-mail to communicate with large groups of students. This occurs, for instance, when a lecture is suddenly cancelled or when an examination has to be rescheduled. In those situations, S&O is unable to contact the students in time through the usual channel of communication of the educational programmes, which is the Education Announcement. S&O also uses e-mail to announce, for example, information sessions about study-related matters.

UT students in general have e-mail addresses such as: <student name>@student.utwente.nl. In this address <student name> is replaced with a person’s initials and surname. Exceptions do occur, especially when a number of UT students have identical initials and surnames.

You can find e-mail addresses of UT students and staff on the UT website, www.utwente.nl/telefoongids.

MyUniversity

MyUniversity, the UT student portal, gives access to all UT data systems (OSIRIS, Blackboard). You can log on at http://my.utwente.nl.

Besides, the portal gives access to the timetables for teaching and to some other services.

Education Announcements

Every Education Announcement (Onderwijsmededeling) is spread through the Internet. The same applies for announcements concerning graduation colloquia and presentations of Bachelor’s and Master’s assignments. You can read them via the MyUniversity portal.

The Education Announcement is the programme’s main means of communication to communicate with all of its students. It is important to check if there are any changes in the timetable every day, in order to be informed as much as possible and to prevent sitting in the wrong lecture-room at the wrong time.

Timetable Course Programme

The portal MyUniversity gives access to the timetables for teaching activities. Changes will be immediately incorporated in the timetables. On the first page of your timetable you will find an overview of the latest changes.
2.5 Student card

The student card issued by the University of Twente is valid proof of identity within the UT and it is also a proof of enrolment. You are required to show the student card at request when making use of university facilities such as attending lectures, taking examinations, or visiting libraries. You will receive your student card and two declarations of enrolment through the post as soon as you are registered. So please see to it that the Central Student Administration (CSA) has your correct address.

Uses of the student card:
- Student card
  - The card is a valid proof of enrolment for the academic year 2012-2013.
- Library pass
  - The student card barcode enables the card to serve as a library pass.
- Xtra card
  - If you want to make use of the sports and cultural facilities in Enschede, the card serves as Xtra card as well. See www.xtra-card.nl/en.

Declaration of enrollment

With a declaration of enrolment you can prove your enrolment (for instance to get a student grant or at your insurance company). The declaration contains, among other things, the programme(s) and the period for which you are enrolled.

Thief / Loss

In case of theft or loss of the card, you can apply for a new student card on payment of EUR 10.- at the Student Services desk in the Vrijhof building.

No student card yet?

If your enrolment has not yet been fully completed, no student card will be produced. In addition to your enrolment the CSA requires a digital photograph. You can upload a recent passport photograph in Osiris.

2.6 Year’s schedules

The year is divided into two semesters, each of which is divided into two quarters. Most courses will take one quarter and will be completed in the same quarter, mostly through a written examination. In every quarter 15 ECTS-credits are scheduled. The quarters run as follows:

- Quarter 1 from week 36 (3 September 2012) until week 45 (9 November 2012)
- Quarter 2 from week 46 (12 November 2012) until week 05 (1 February 2013)
- Quarter 3 from week 06 (4 February 2013) until week 16 (19 April 2013)
- Quarter 4 from week 17 (22 April 2013) until week 26 (28 June 2013)

Resits will take place in weeks 27 (1-5 July) and 30 (22-26 July)

For the exact schedule of courses see the timetables on the website http://myutwente.nl. For a brief summary in English: www.utwente.nl/so/roosterwerkgroep/en.

2.7 Lectures

The lecture hours on a 3TU level are identical at all three of the institutes. This facilitates the exchange of education between the 3TU institutes by means of real time video conferencing.

The lecture hours fit in very well with a very simple and straightforward model: all lecture hours start at a quarter to the hour and end at the half hour.

There are fifteen-minute breaks between lecture hours, lunch and dinner breaks last 75 minutes. Starting times of written examinations fit in with this schedule. The longer breaks between the morning and afternoon lectures and the afternoon and evening lectures respectively, are included in a consecutive numeration.

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st period</td>
<td>08:45 - 09:30</td>
</tr>
<tr>
<td>2nd period</td>
<td>09:45 - 10:30</td>
</tr>
<tr>
<td>3rd period</td>
<td>10:45 - 11:30</td>
</tr>
<tr>
<td>4th period</td>
<td>11:45 - 12:30</td>
</tr>
<tr>
<td>5th period</td>
<td>12:45 - 13:30</td>
</tr>
<tr>
<td>6th period</td>
<td>13:45 - 14:30</td>
</tr>
<tr>
<td>7th period</td>
<td>14:45 - 15:30</td>
</tr>
<tr>
<td>8th period</td>
<td>15:45 - 16:30</td>
</tr>
<tr>
<td>9th period</td>
<td>16:45 - 17:30</td>
</tr>
</tbody>
</table>

2.8 Taking courses

You need to sign up for each course via Blackboard and Osiris. To get access to the courses you require an account. The ICTS will provide you with a user name and password.

2.9 Knowing your way around campus

All of the faculty of EEMCS teaching takes place in rooms situated in buildings which are spread all over campus. In the time tables the lecture rooms are indicated using a code in which the first two letters indicate the building where the room is situated. The list below contains the most frequently occurring abbreviations of buildings. The computer practicals generally take place in one of the Zilverling rooms.

<table>
<thead>
<tr>
<th>Code</th>
<th>Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>Citadel</td>
</tr>
<tr>
<td>CR</td>
<td>Carré</td>
</tr>
<tr>
<td>CU</td>
<td>Cubicus</td>
</tr>
<tr>
<td>HB</td>
<td>Hal B (main entrance Zilverling, Carré and Waaijer; location servicedesk Carré)</td>
</tr>
<tr>
<td>HO</td>
<td>Hogekamp</td>
</tr>
<tr>
<td>HR</td>
<td>Horstring</td>
</tr>
<tr>
<td>HT</td>
<td>Horstotten</td>
</tr>
<tr>
<td>LA</td>
<td>Langezijds</td>
</tr>
<tr>
<td>RA</td>
<td>Ravelijn</td>
</tr>
<tr>
<td>SC</td>
<td>Sportcentrum</td>
</tr>
<tr>
<td>SP</td>
<td>Spiegel</td>
</tr>
<tr>
<td>VR</td>
<td>Vrijhof</td>
</tr>
<tr>
<td>WA</td>
<td>Waaijer</td>
</tr>
<tr>
<td>ZI</td>
<td>Zilverling</td>
</tr>
</tbody>
</table>

For a map of the University of Twente see the next page or www.utwente.nl/plattegrond.
2.10 Study materials
Textbooks, lecture notes, readers or syllabuses are required for virtually every course. For those you can turn to the student association and the UnionShop.

The lecture notes, readers and syllabuses will be sold from the beginning of every semester at the UnionShop. You can check the website to see if they are in stock: www.studentunion.utwente.nl/en

2.11 PC-privé scheme for UT students
The UT offers the possibility of an interest-free loan for the acquisition of the notebook provided by the NSC. The exact arrangements and conditions for the loan can be found in the students statutes. With the interest-free loan, the University of Twente will advance the funds necessary for your Notebook, which you will have to pay back to the University within 24 months. The maximum amount that you can borrow from the UT is 1,000 euros.

Principal requirement:
Once in the Bachelor’s phase and once in the Master’s phase, provided the student in question is 60 ECTS-credits or more away from the degree in the respective phase.

Exceptions:
1. When attending a one-year Master’s course, the student may sign up for the scheme no later than one month after the beginning of the programme;
2. Students enrolled in a Bachelor’s programme who take courses in the Bachelor’s phase as well as in the Master’s phase and who still have to attain at least 60 ECTS-credits for both phases taken together are also entitled to take part in the scheme. Taking part in the scheme is then regarded as taking part during the Master’s phase.

Note: this also includes students entering a programme via an alternative route who are attending a so-called ‘bridging programme’.

As a UT student you can purchase a high-quality notebook at the Notebook Service Centre at a highly competitive price along the service guarantee that after handing the notebook in at the service desk you will obtain a working model within one hour. Obviously the notebook will also fulfil the requirements set by the universities bachelor’s programmes. The Notebook Service Centre also provides general UT software (such as Maple, Virusscanner, SPSS) through downloads. Special software may be available via your faculty.

For more information on the PC-privé scheme, refer to:
www.utwente.nl/so/studentenbegeleiding/en/regulations/notebook/
3 UT REGULATIONS

3.1 Studiefinanciering
The contribution of the Dutch government towards the cost of education is called studiefinanciering. It consists of either a conditional grant plus an additional loan (the so-called blended studiefinanciering), or just a loan. The grant of DUO (Dienst Uitvoering Onderwijs, the government institution responsible for the Dutch student grants) allows students to receive part or all of their training outside the Netherlands. The entitlement to studiefinanciering depends on your first year of enrolment. In any case, you have to be enrolled as a student and you should not be over 30.

If you have any questions about the UT regulations below, you can also consult your study adviser.

3.2 Regulation graduation support
Students at the UT with certain special circumstances can make use of the Regulation graduation support. Students can appeal to this regulation when they have run into a delay due to recognized special circumstances during a period of blended studiefinanciering. The blended studiefinanciering concerns the period for which the studiefinanciering can partially be converted to a gift; in other words: the period in which the student is entitled to the basisbeurs (basic grant). To apply for graduation support you can contact the student counsellor in the Bastille building.

www.utwente.nl/so/studentenbegeleiding/en/regulations/graduationsupport

3.3 Top-level sport
Combining university-level studies and top-level sport can be problematic for many students. It generally proves impossible to postpone either academic studies or a career in sport until later; both activities require the practitioner to achieve results within a relatively short period of time. The UT is aware of the problems involved and has developed a policy covering the practice of top-level sport.

See also: www.utwente.nl/so/studentenbegeleiding/en/regulations/topsports/

3.4 Regulation encouragement student activism
Within the framework of encouragement of student activism there is a special regulation for active students. This involves the individual readjustment of educational obligations for active students, in order for them to have more flexibility in their studies and so that they will run into less delay because of their activism. If you want to know if you qualify for this regulation or if you want more information, go to: www.utwente.nl/so/studentenbegeleiding/en/regulations/graduationsupport or www.utwente.nl/so/studentenbegeleiding/en/regulations/ravis

3.5 Studying with a disability
Being disabled, following an educational programme is not always easy. However, the UT makes a serious effort to enable the disabled to study. Physically or sensory disabled students or dyslexic students are given the opportunity to take examinations in a way that is tailored to the requirements of their personal disabilities as much as possible. Students who fall under this regulation have been brought to the attention of S&O/BOZ and the EEMCS lecturers concerned through a letter of the study advisor.

www.utwente.nl/so/studentenbegeleiding/en/counselling/firstyear/introductionprogramme/
www.utwente.nl/so/studentenbegeleiding/en/counselling/firstyear/register

In general, being disabled, it may be wise to talk to the student counsellors and the study advisor of the faculty before the start of your studies. This may prevent any disappointments.
4 UT FACILITIES

4.1 Office for Educational Affairs EEMCS
The Office for Educational Affairs (BOZ, Bureau Onderwijszaken) of the faculty of EEMCS is part of the Student & Education Service Centre (S&O) and assists the faculty in registering study results, supervising the (individual) students’ study programmes, organizing everything surrounding final assessment, making timetables, organizing examinations and organizing administrative systems. BOZ is situated on the second floor of the Citadel, rooms H205-209. You can turn to them with most of your practical questions. They are reachable by telephone number +31 53 489 3784 or by e-mail boz@ewi.utwente.nl

In addition to this, you can turn to Student Services on the first floor in the Vrijhof building with any questions concerning education.

4.2 Union Shop
The UnionShop is situated on the ground floor in the Bastille building. The UnionShop sells lecture notes, readers and syllabuses. It also runs a copy service. In the self-service section not only copies can be made, but also reports can be bound, flyers cut, etc.

4.3 Notebook Service Centre
Nowadays, a notebook is virtually indispensable to any student at the University of Twente. You require your notebook to communicate with others, to collect information, to make calculations and drawings, to perform simulations and even to take examinations.

Are you planning to buy a notebook in July or August? Every year in the summer, the ICTS Notebook Service Centre of the UT selects notebooks which most assuredly will meet the requirements of your educational programme!

On the Notebook Service Centre website various software packages are available for download, including Maple, Matlab, Solidworks, SPSS, VanDale etc. For more information, go to: www.utwente.nl/icts/en/nsc

Service desk
All students and university staff members can turn to the ICTS Service desk if they have problems or questions in the field of ICT. The ICTS Service desk is open from 08.30 until 17.00h and is reachable by telephone number +31 53 489 5577.

The service desk is situated in Horstring W122 (next to the Notebook Service Centre). With ‘general’ questions on ICTS you can turn to icts.servicedesk@utwente.nl. For more information, go to: www.utwente.nl/icts/en/servicedesk.
5. STUDY ASSOCIATIONS

Organizing various activities requires qualities and skills which you may benefit from for the rest of your life. So being active in an association (being on a committee or a board) will always be beneficial to your CV. In the professional field, surely students will be watched for who did more than just study.

Being active also helps you getting introduced to people you might never meet otherwise. Moreover, board members often have a specific position, such as chairman, secretary or treasurer. Positions like this will teach you how to draw up an agenda, to chair meetings, to take minutes or, for instance, to draw up an estimate.

Every educational programme has its study association. They all organize all sorts of study-related activities, such as lectures, excursions and conferences. But also recreational activities are laid on, such as get-togethers and parties. In addition, the student association for instance takes care of the book sale.

The study association for Electrical Engineering is Scintilla, for Creative Technology this is Proto, Abacus is the study association for Applied Mathematics and Inter-Actief for Computer Science.

Student participation and other committees

Within the faculty of EEMCS of your study programme you may become a member of various committees, such as the Faculty Council, Programme Committee or the Programme Quality Committee.

4.4 Bibliotheek/informatiespecialist EWI

The central library of the University of Twente, situated in the Vrijhof building, contains books and journals on a number of disciplines. In addition, it contains study facilities such as study places in the reading rooms, quiet study places, working areas and PC work areas. The University Library catalogue, which includes the faculty libraries and the central library, is available online (www.utwente.nl/ub/en). Here you can also consult the catalogues of all Dutch University Libraries.

You need a student card if you want to lend publications or if you want to make use of the study facilities, for the student card serves as a library pass. Further information on lending or ordering publications is available at the desk of the library. The University of Twente is working on the accessibility of scientific journals. More and more journals can be consulted through the Internet.

The opening hours of the central library are from 08.30 until 22.00h on workdays, and from 9 until 16.30h on weekends (for study purposes only). The information desk is open from Monday to Friday from 08.30 until 17.00h. You will find more information on www.utwente.nl/ub/en.

The University of Twente has a team of information specialists who offer support in the purchase of books, provide information on how to use the (digital) library and how to find scientific information on research and education for both staff and students. For EEMCS, the information specialists are:

- Mrs drs. P. (Petri) de Willigen, Citadel building H203, phone +31 53 489 2085

4.5. Student restaurant

In the Waaier building, the student restaurant of the UT is situated. The restaurant is based on the so-called free-flow system, which means that at various free-standing points of distribution a broad assortment is offered. Here you can get a hot day’s menu, the Dagmenu. You can also choose to have the more luxurious menu, or select from a broad assortment of sandwiches, rolls, snacks, desserts and hot and cold drinks.
Although every effort has been made to ensure that all the information presented is correct, information in this study guide is subject to changes. No rights may be derived from the information in this guide. For up-to-date information refer to: www.utwente.nl/ewi/en/education