Course Regulations

M.Sc. Information and Communication Engineering

Implementary Regulations with supplements
I: Study and Examination Plan
II: Description of Competencies
III: Module Handbook
IV: Internship Regulations

TECHNISCHE UNIVERSITÄT DARMSTADT

Agreement of Department Council on 29.04.2014

Signature of the Dean on 21.07.2014

Regulations come into effect on 01.10.2014

Course Regulations as of 29.04.2014

0. Table of Contents

1. Implementary Regulations

To § 2 (1): Academic degree

The research-oriented course of studies Master of Science (M.Sc.) “Information and Communication Engineering” is administered by the department Electrical Engineering and Information Technology of the Technische Universität Darmstadt. The Technische Universität Darmstadt will award the degree Master of Science (M.Sc.) when a student has achieved the required number of credit points according to the Study and Examination Plan (Supplement I).

To § 3 (5): Timing of examinations

1. The time limits for examinations (“Fachprüfungen” and “Studienleistungen”) are defined in Supplement I of this document.
2. The following rule applies especially to all mandatory modules from the first two semesters as they are described in the catalogue of mandatory modules: The examinations for these modules must be taken for the first time within the semester to which they belong.
3. It is recommended that all examinations be completed in the order given in Supplement I and written directly following the completion of the related course/lecture.

To § 5 (2): Modules, components and types of examinations

Every module description in the Module Handbook (Supplement III of this document) defines if an examination or course work can be repeated as often as necessary (“Studienleistung”) or if the repetition is limited (“Fachprüfung”). Internships, project seminars, (pro-)seminars and seminars are usually graded “Studienleistungen” (can be repeated as often as necessary). Lectures and the related tutorials are graded “Fachprüfungen” (can be repeated only a restricted number of times). One exception is the catalogue “Studium Generale”. Modules out of this catalogue may in some cases also be completed in the form of an ungraded “Studienleistung”.

To § 5 (4), (5): Modules, components and types of examinations

The type for each examination (oral, written, special form, term paper, course-accompanying) is defined in the module description for each module in Supplement III.

To § 11 (2): General admission requirements – Internship

1. Students are required to complete a 12-week technical internship in the area “Information and Communication Engineering”.
2. Students should complete the Internship before beginning studies. In justified exceptions, the internship can be completed during the course of studies up until the registration of the final thesis.
3. A more detailed description can be found in Supplement IV of this document (Internship Regulations).

To § 11 (4) or (5): General admission requirements – Language skills

The language of instruction for the degree is English. This is especially important for the courses in the first year of study. Some courses are also offered in German throughout the following semesters of study.

To § 12 (2): General proof of registration for examinations

In the case of a subject combination in the elective area ("Wahlbereich") that deviates from the recommendations in Supplement I, an individual examination plan must be approved by the Examination Committee. This must be submitted at the latest by the time of registration for the first examination in the elective area (see also regulations to § 27 (5)).

To § 17a (1) to (5): Entry requirements to master's programmes

1. Entry requirement to the master's program "Information and Communication Engineering" is a bachelor degree in "Electrical Engineering and Information Technology" with a suitable area of specialisation ("Vertiefung") from the Technische Universität Darmstadt or a degree that imparts the same competencies (equivalent degree). The requirements are tested in an entrance examination.
2. The entrance examination is a test of competencies. It includes content out of the main mandatory courses from the precursory bachelor's programme, covering the core competencies described in Supplement II. Through the entrance examination, applicants should display competencies in these subject areas at a level that would allow them to successfully complete the master's degree in "Information and Communication Engineering" at the Technische Universität Darmstadt.
3. The Examination Committee can exempt an applicant from the entrance examination if they provide proof in one of the following ways of the necessary standards to successfully complete this master's degree: (a) successful completion of an equivalent bachelor's degree or (b) with a suitable entrance examination from another university or private service.
4. The entrance examination is based on examinations from all courses covering the core competencies described in Supplement II. The Examination Committee decides on the form, date and examiners. Particularly, the Examination Committee can require an online-test as part of the entrance examination.
5. The admission of an applicant by the Examination Committee can be restricted with additional requirements of up to 30 credit points. These additional requirements are in the form of additional examinations ("Fachprüfungen") to be completed within a defined deadline. These examinations should ensure the necessary qualifications for the master's course of studies. Examinations as part of these additional requirements must be completed at the latest in the semester in which these courses are normally offered. Enrolment in the case of restricted admission is subject to the regulations under § 54, par. 4 HHG.
6. Applicants with non-equivalent degrees that are, however, very similar, can be admitted to preparation studies ("Vorbereitungsstudium") lasting a maximum of two semesters. The preparation studies end at the latest by the end of the second semester.
7. Admission to preparation studies takes place as defined in § 54 par. 4 HHG on the condition that all examinations in the subjects covering the core competencies as defined in Supplement II be completed within two semesters. Further additional requirements of up to 23 credit points may also be required based on the individual competencies required in the master's programme "Information and Communication Engineering".
8. The Examination Committee must approve the completion of any "Fachprüfungen" or "Studienleistungen" in the normal master's programme during the preparation studies, with the exception of the modules in the area of "Non-Technical Electives".
9. If any one of the modules defined in the additional requirements is not completed up to the end of the preparation studies, the candidate will be ex-matriculated according to § 59, par. 2. No. 6 HHG. A certificate will be issued of any examinations completed.

10. When a student has completed all of the required additional modules within the preparation studies he or she will be admitted to the master's programme and a certificate of examination results will be issued. Upon request, the examination results from the preparation studies can be printed as additional examinations in the final transcript.
11. An additional admission requirement is English language level C1 according to the Common European Framework. The required proof of language competency can be achieved in consultation with the Language Centre ("Sprachenzentrum") of the Technische Universität Darmstadt with: (a) an equivalent certificate of a language test or (b) certified proof of an English-language bachelor's degree in the appropriate subject area.

To § 18 (1): Admission requirements

The admission requirements for each module are defined in Supplement III in the paragraph "Requirements for participation" ("Voraussetzungen zur Teilnahme") of the module description.

To § 20 (1): "Fachprüfungen" and "Studienleistungen"

The achievement of the Master of Science requires the completion of "Fachprüfungen" (technical examinations whose repetition is limited) and "Studienleistungen" (examinations or course work that can be unlimitedly repeated) in the modules described in Supplement I, to a total of 180 credit points.

To § 23 (2): Final thesis – Topic and prerequisites

The department "Elektrotechnik und Informationstechnik" assigns the final thesis topic (Master Thesis). Advising of the Master Thesis takes place at one of the Chairs ("Fachgebiete") within the department.

The Master Thesis can be assigned only when all additional requirements as described in § 17a have been fulfilled. Furthermore, a minimum of 75 credit points must have been acquired, the language examination of the catalogue "languages" successfully completed and the technical internship approved according to the Internship Regulations (see Supplement IV). Additionally, the Master Thesis must not have a content closely related to the content of the practical internship.

To § 23 (5): Final thesis – Working time

The final thesis must be completed within 26 weeks and encompasses a total working time of 900 hours. The submission date is to be set before beginning the thesis at the time of registration of the thesis at the study office.

To § 25 (3): Formation and weighting of grades

The weighting of each grade for "Fachprüfungen" and "Studienleistungen" in the calculation of module grades is defined in Supplement I. Ungraded "Studienleistungen" carry a weight of "0" and are not carried into the final module grade. If in Supplement I not otherwise stated, examination grades as parts of modules are weighted according to the number of credit points ascribed to them.

To § 27 (5): Pass and fail – Elective areas ("Wahlbereiche")

The required examination achievements in the elective areas ("Wahlbereiche") are defined in Supplement I, in the study plan or examination plan, or in an individual study plan and examination plan, that must be approved by the Examination Committee. Students receive the council of their mentors when constructing an individual examination plan. The Examination Committee must provide a reasoned explanation for a decision not to approve an individual study plan.

To 28 (3): Total grade

The weight of each module grade for the total grade is defined in Supplement I of this document, the Study and Examination Plan. Modules that only include ungraded “Studienleistungen” receive a weight of “0”. These are not taken into account in the final grade. As long as not otherwise stated in Supplement I, the module grades are taken into the final grade according to the number of assigned credit points.

To § 30 (2): Repeating examinations

1. For all mandatory modules from the Catalogue of Mandatory Modules from the first two semesters as defined in Supplement I, the following rule applies: Beginning in the third semester of study, all examinations from modules from the first semester that have not yet been passed, must be attempted again at the soonest possible time. Starting in the fourth semester, all examinations from the second semester that have not yet been passed, must be attempted again at the soonest possible time. In the case of approved exemptions these examinations must be written for the first time.
2. For all other examinations (“Fachprüfungen” and “Studienleistungen”) that have not yet been passed, it is recommended to write these examinations in the semester in which the corresponding course is normally offered.

To § 39 (2): Coming into effect

These Implementary Regulations come into effect on 01.10.2014. They will be published in the “Satzungsbeilage” of the Technische Universität Darmstadt.

Attachment I	Study and Examination Plan
Attachment II	Description of competencies
Attachment III	Module Handbook
Attachment IV	Internship Regulations

Darmstadt, den 21.07.2014

Prof. Dr.-Ing. Abdelhak Zoubir
Der Dekan des Fachbereichs Elektrotechnik und Informationstechnik
der Technischen Universität Darmstadt

1.1. Supplement I: Study and Examination Plan

The study and examination plan is published (electronically) as a separate document:
Studien- und Prüfungsplan „Information and Communication Engineering“ | M.Sc. (Stand 29.04.2014)

1.2. Supplement II: Description of Competencies

1.2.1. Prerequisite competencies

The following is a description of selected competencies that are acquired during the B.Sc. "Elektrotechnik und Informationstechnik" at the Technische Universität Darmstadt with a specialisation in an area such as "Computer Engineering", "Communication Technology and Sensor Systems", "Micro and Precision Engineering" or "Integrated Micro- and Nano-Technology". These competencies are prerequisites for the M.Sc. "Information and Communication Engineering". These competencies are characteristic for the demands of the master's programme. Therefore, they are a central requirement for the successful continuation of studies in the master's programme, which builds upon the bachelor's programme. Every graduate of this programme acquires, among others, the following experiences and skills: Graduates acquire intensive and comprehensive practice in largely independently solving assignments based on the content of the mandatory courses in the programme. Graduates are able, through the organisation of the study programme, to independently organise their workload within narrowly defined parameters and various timelines (up to a scope of several semesters). This means:

- *Intensive* and *comprehensive*: these competencies are not only gathered at certain points (as in courses specifically oriented to the topic); rather they continue over the entire course of studies, if not in every course to the same extent.
- *Independent*: that the job of instruction and support services is essentially to provide an orientation and clarify the task. The students must – depending on the assignment – work out tasks on their own or in teams.

The assignments given are usually transfer tasks, requiring creativity and abstract thought in the solution. The expectations may be described in detail as following:

Core competencies for the programme "Information & Communication Engineering" (M.Sc.)

The core competencies required for the M.Sc. "Information and Communication Engineering" may be traced back to the qualification goals ("Qualifikationsziele") of the B.Sc. Programme "Elektrotechnik und Informationstechnik" with an appropriate area of specialisation at the Technische Universität Darmstadt. The following modules play an important role in the entrance examination for the M.Sc. "Information and Communication Engineering" (see Implementary Regulations to §17a, point 4)

- Analog Integrated Circuit Design
- Deterministic Signals and Systems
- Communication Technology I
- Mathematics IV

A student is, able to derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), understands simulation methods for analog circuits on transistor level using SPICE, analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, derive and calculate the analog propierties of digital logic gates .

A student possesses the ability of comparing, evaluating, classifying an analyzing linear and nonlinear modulation schemes by means of signal space representations; the ability to understand, describe and analyze the influence of multipath propagation on the signal; the knowledge of equalizing the received signal in order to undo the influence of multipath propagation, as well as the ability to derive and design several equalizer structures; the ability to analyze and evaluate the properties and application

areas of multicarrier transmission systems, e.g. OFDM-systems; the ability to design and evaluate the system parameters of multicarrier schemes for the application in realistic mobile radio szenarios; the ability to characterize and evaluate spread spectrum techniques;the ability to apply multiple access transmission to multicarrier schemes and spread spectrum techniques (OFDMA, CDMA).
A student knows the specific properties and principle construction of electronic measurement equipment; know the fundamental principles of measurement data acquisition, processing, communication and storage, knows sources and root causes for errors and can quantify them. The students know principle concepts of digital circuits, are able to synthesize Boolean functions in a two-stage concept using Veitch diagrams, can represent Boolean functions by using decision diagrams, are able to realize functional diagrams with synchronous logic, can adapt gate level logic to given technologies, are able to transform specifications to functional diagrams, and are able to verify the time-constraints on a synchronous logic circuit for consistency.
Students are able to derive fundamental properties of the MOS-transistor from its fabrication process resp. layout properties, can derive fundamental MOS-circuits and know their properties and parameters. Students know the simulation concepts for analog circuits on transistor level and are able to analyse feedback amplifiers w.r.t frequency response and stability, bandwidth, root loci, amplitude and phase stability. They know the fundamental analog properties of digital logic gates and are able to derive them. Students understand the fundamental concepts of signal processing. They know how to analyse deterministic and statistical signals in the time- and frequency domain. They know how to analyse stochastical signals and know the statistical methods of signal processing.
Students know selected, fundamental concepts of photonics and understand the physical principles behind them, and are able to apply them in selected engineering and scientific domains. Students know how to apply the fundamental methods of communications to practical problems, and have advanced knowledge on selected field of communications (e.g. communication technology, radio frequency, signal processing, etc).
Students know the fundamental principles of integraltransformation and are able to apply them to physical problems. They possess the mathematical knowledge to model and analyse typical problems in engineering. They know fundamental properties of ordinary differential equations and their explicit approach to derive solutions. Students have basic knowledge of complex function theory. Students are able to select numerical algorithms for fundamental mathematical problems and apply them successfully. They are able to perform statistical analyses, fundamental estimations and test methods.
Students have a good understanding of wave propagation properties in free space and conductors, are able to recognize wave propagations in applications and understand their impact. They are able to derive the wave properties from Maxwells equations and possess the required mathematical knowledge for the derivations.

Further competencies for the programme “Information & Communication Engineering” (M.Sc.)

Students are able to apply fundamental equations of electrical engineering and know how to calculate currents and voltages on linear and nonlinear two-ports, are able to calculate the basic properties of DC and AC networks, can analyse simple filter and apply complex number theory for deriving solutions. Students have understood that effects in electrical engineering are not necessarily bound to conductors and wires. They have a good understanding of electrical and magnetic fields, know how to read images of electrical and magnetic fields and construct simple images. They know the difference between vortex fields and source fields and know how to mathematical describe them, resp. are able to differentiate them based on a mathematical formula.
Students have basic concepts of programming and are able to operate a computer. They are able to develop Java programs and make use of fundamental algorithms and data structures, and know the concepts of object oriented programming. They are able to work in teams and apply successfully structural programming techniques on given code. They know how to implement code, test and document not too complex software projects. They have the fundamental knowledge to apply software-engineering techniques for the development of large software projects.

Students know elementary methods of mathematical clauses and logic derivations. They know the concepts of linear algebra, analytical geometry and function analysis with real parameters. They have an advanced knowledge of mathematical principles, know the fundamental properties of function analysis with more than one unknown and are able to apply this knowledge to engineering problems.
Students understand the fundamental concepts of physical layer communications, the signal transport from a source to the load, possible signal transport mechanism, sources for errors and distortions/noise during signal transport and options how to suppress this noise. Students are able to classify signals and communication systems, understand modules of simple communication systems, and are able to derive and analyse models w.r.t. various criteria. They know how to analyse and compare ideal communication channels with white noise excitation, and are able to model base-band communication structures. Students can model and analyse bandpass signals and modules, and describe them in the equivalent baseband. They understand linear digital modulation techniques and are able to model, assess, compare and apply them. Students know how to design receiver structures for different modulation techniques, can optimally detect linear modulated data after transport over ideal white noise affected channels.

Proseminar work, project internships and bachelor thesis: The ability to work independently on a confined topic in the area "Information and Communication Engineering" using scientific methods in a defined timeline under the following conditions:

- Formulating a research question and answering it to the extent possible considering the current state of research.
- Carrying out an independent and comprehensive literature study, in which the sources used reflect the current state of research and are to a large extent in the English language.
- The work on the topic must contain a creative portion, which can be assisted by independently acquired criteria, such as an independent analysis, construction, programming or a materials systematisation.
- The results are presented in a presentation and put up for discussion.

Entrance requirements for the programme "Information & Communication Engineering" (M.Sc.)

All of the competencies described above are crucial for the successful completion of the M.Sc. Programme "Information and Communication Engineering". The core competencies detailed above have an especially important role. They therefore play a central role in the admissions process – detailed further in the Implementary Regulations to § 17a of the General Examination Terms of the Technische Universität Darmstadt – for the master's programme "Information and Communication Engineering".

1.2.2. Qualification results

Through the research-oriented M.Sc. programme “Information and Communication Engineering” at the Technische Universität Darmstadt, students expand upon technical and interdisciplinary competencies gained in a previous bachelor's degree. These competencies are characteristic of the course of studies in question and are a central prerequisite for following doctoral studies. After completing the course of studies, students are able to:

- Use their improved methodological skills to independently process complicated problems and tasks in Information and Communication Engineering, taking into consideration various approaches.
- Apply these skills even in unfamiliar situations with incomplete information and thus be able to think of them in system relationships.
- Solve tasks and problems with a high degree of abstraction and an eye for complex relationships.
- Recognise future problems, technologies and scientific developments and take these into account appropriately in their work.
- Communicate the results of their analysis and elaborated solutions to other specialists and lay people even in a foreign language.
- Efficiently organise and carry out complex projects, as well as build and lead teams in a goal-oriented way.
- Assess and take into account the social and ethical responsibilities of the work they do.
- Continually and independently improve their knowledge and carry out largely independent scientific work.

In summary, the master's programme differs from the previous bachelor's programme primarily in the following ways: the focus is greatly on solving more complex problems using incomplete information, a higher level of abstraction and being able to deal with complex system dependencies. Furthermore, the master's programme places an increased importance on the ability to work with current research literature, to work scientifically in a specialisation of the students' choice and on practice orientation.

1.3. Supplement III: Module Handbook

The Module Handbook is published electronically according to § 1, par. (1) of the *Satzung der Technischen Universität Darmstadt zur Regelung der Bekanntmachung von Satzungen der Technischen Universität Darmstadt* from March 18th 2010 as:
Modulhandbuch „Information and Communication Engineering“ | M.Sc. (Stand 29.04.2014)

1.4. Supplement IV: Internship Regulations

The internship regulations are published as a separate document:
Praktikantenordnung „Information and Communication Engineering“ | M.Sc. (as of 29.04.2014)