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TECHNISCHE UNIVERSITÄT ILMENAU

Examination and Study Regulations -Special Provisions - for the program *Communications and Signal Processing* with the degree "Master of Science"

According to § 3 para. 1 in conjunction with § 38 para. 3 of the Thuringian Higher Education Act (ThürHG) of 10 May 2018 (GVBl. p. 149), last amended by Article 7 of the Act of 23 March 2021 (GVBl. pp. 115, 118), the Technische Universität Ilmenau (hereinafter referred to as "University") issues the following Examination and Study Regulations - Special Provisions - for the degree program Communications and Signal Processing with the degree "Master of Science", published in the University Gazette No. 211 / 2021, based on the Examination and Study Regulations - General Provisions - for study programs with the degree "Bachelor", "Master" and "Diploma" of the university as published in the University Gazette No. 174 / 2019, last amended by the Second Amendment Statute, published in the University Gazette No. 184 / 2020.

The Council of the Department of Electrical Engineering and Information Technology approved these Regulations on 2 March 2021. The Academic Committee issued a positive opinion in a resolution dated 30 March 2021. The President approved them on 5 May 2021.

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A. General regulations

§ 1 Scope of application

(1) The Examination and Study Regulations - Special Provisions - for the degree program Communications and Signal Processing with the degree "Master of Science" determine the contents, objective, structure and organization of the degree program as well as details of the examination procedure in the mentioned degree program on the basis of the Examination and Study Regulations - General Provisions - for degree programs with the degree "Bachelor", "Master" and "Diploma" of the University (PStO-AB), published in the University Gazette No. 174 / 2019 in the respective valid version. The annexes are part of these regulations.

(2) All references to persons and positions shall apply in the same way irrespective of gender.

B. Studies and degree program

§ 2 Academic degree

The university, on the proposal of the Department of Electrical Engineering and Information Technology, awards students who successfully complete this Master's program the academic degree

"Master of Science"

as further professionally qualifying academic degree.

§ 3 Study requirements and prior knowledge

In addition to the general admission requirements to a Master's degree program according to the Thuringian Higher Education Act, the admission requirements for this degree program shall apply as specified in the annex "Special Admission Requirements".

§ 4 Objectives of the program, occupational field, profile type

(1) The degree program aims at a research-oriented deepening of the technical and methodological competence in communications engineering and signal processing in general, which has already been acquired in a university degree program and, if applicable, in a practical professional practice, as well as the gaining of special systems engineering knowledge in the fields of communication networks, mobile communication and array signal processing - especially with regard to future communication systems. In addition, the ability to work in a team, social competence and communication skills are to be developed to a high degree during the program. In the annex "Profile Description", the qualification goals, content-related aspects of the degree program and the demand for graduates in the industry are described in detail.

(2) The degree program is consecutive with a profile of "research-oriented" according

to § 4 Thüringer Studienakkreditierungsverordnung (ThürStAkkVO, ordinance on accreditation of degree programs).

§ 5 Standard length of study

According to § 52 ThürHG, the standard length of study is four semesters. The degree program begins in the winter semester.

§ 6 Content, structure, and scope of the degree program; curriculum

(1) The curriculum (annex) outlines the content as well as the structure of the studies in such a way that the degree program can be completed with all final examinations and the Master's thesis (§ 14) within the standard length of study according to § 5.

(2) The program covers a total of 120 credit points (LP/ECTS).

(3) In addition to the subject-specific modules, students are also recommended to attend the optional classes offered by the university exceeding the curriculum's requirements (annex).

(4) Self-study is essential for gaining specialized knowledge and for the deepening and broadening of the subjects' contents presented in the lectures and classes.

(5) Students aiming for the academic degree in a double degree program based on a cooperation agreement with a partner university shall, unlike the curriculum described in the annex, complete classes at the partner university in accordance with the provisions of the respective cooperation agreement and its amendments.

(6) According to § 3 para. 7 PStO-AB, the corresponding regulations are defined in the annex "Competence goals and regulatory area elective course catalogues".

(7) The third semester is particularly suitable for a stay abroad during the program, and the fourth semester for writing the Master's thesis. An individual study agreement must be signed for this purpose. For the recognition of the achievements abroad, § 26 PStO- AB applies.

(8) Students shall be invited to participate in the university's self-governing bodies, including the student body.

§ 7 Admission to program segments, admission to modules

There are no special professional (qualitative and quantitative) requirements for admission to program segments and modules.

§ 8 Student advisory service

As recommended by the Academic Program Committee, the Department of Electrical Engineering and Information Technology appoints a study advisor. Individual study counselling on organizational and examination-related issues is provided by the study

advisor and the Education Office / Examination Office of the Department of the Department of Electrical Engineering and Information Technology.

§ 9 Language of instruction and examination

(1) English is the language of instruction and examinations in the degree program Communications and Signal Processing. The language of the examination corresponds to the language of the class.

(2) Students who are interested in an academic degree in a double degree program (Double Degree) based on a cooperation agreement with a partner university (§ 9 PStO-AB), should consider that classes and exams are held in the partner university's usual language of instruction and examination. The provisions of the cooperation agreement and its supplementary agreements apply to the Master's thesis.

C. Examinations

§ 10 Admission to examinations

There are no program-specific requirements for admission to examinations.

§ 11 Type, form, and duration of examinations; deadlines

(1) The type of examination to be taken (§ 10, para. 1 PStO-AB) is specified in the curriculum. The form and duration of the examination (graded and non-graded examinations) shall be determined by the module officer in the module description (§ 11 paragraphs 1 to 7 PStO- AB).

(2) Alternative academic achievements, which must be provided in writing, can be supplemented by a colloquium (§ 11 para. 5 PStO-AB).

(3) If the examinations to be taken in the first two semesters according to the curriculum (annex) are not taken by the end of the second semester after the semester provided for in the curriculum (annex), the examinations not yet taken shall be deemed to have been taken for the first time and not passed, unless the student is not responsible for the failure; § 21 paragraph 4 PStO-AB shall apply accordingly.

§ 12 Second resit of examinations

According to § 19 para. 1 PStO-AB, three graded examinations can be repeated a second time.

§ 13 Grade improvement and free attempt (Freiversuch)

In accordance with § 21 para. 1 PStO- AB, an examination that has not been passed for the first time is deemed not to have been taken upon application if it was taken for the first time before or in the semester recommended in the curriculum (annex; Freiversuch/free attempt). Section 21 para. 2 PStO-AB applies to the improvement of

grades. According to § 21 para. 3 PStO-AB four free attempts and grade improvements (total number) can be claimed.

§ 14 Master's thesis

(1) According to § 24 PStO-AB, the Master's thesis is an examination in the fourth semester. It consists of the written scientific assignment and a colloquium (§ 24 paragraph 1 PStO-AB). The grade of the Master's thesis is determined by 2 / 3 ref. to the arithmetic mean of the grades of the expert opinions and 1 / 3 of the grade of the colloquium.

(2) Admission to the Master's thesis requires the successful completion of academic achievements and (graded and non-graded) examinations listed in the curriculum (annex) amounting to at least 85 credit points. The topic is usually issued at the end of the third semester.

(3) In accordance with § 9 in conjunction with Annex 1 PStO-AB, the cooperation agreements and their supplementary agreements for double degree programs may contain provisions that differ from the provisions outlined here.

(4) The thesis covers a workload of 750 hours / 25 credit points and must be completed within 5.5 months. The processing period begins at the time determined by the examination board according to § 24 paragraph 7 PStO-AB.

(5) Students are only admitted to the colloquium when they have proven that they have completed all the coursework and examinations listed in the curriculum (annex), with the exception of the Master's thesis, and the Master's thesis has been submitted to the Examinations Office of the Department of Electrical Engineering and Information Technology in due time.

The colloquium consists of a talk of about 30 minutes in which the student presents the results of his/her thesis and a subsequent discussion of about 30 minutes. Five credit points are awarded for the colloquium.

It usually takes place no later than two weeks after the submission of the thesis, but only after the admission requirements have been met.

The colloquium is assessed/graded by two examiners. One of the examiners should be the supervising professor.

(6) The topic and supervision for the Master's thesis are always the responsibility of the respective supervising university teacher, who must be a professor, a junior professor or a habilitated staff member of a group of the Department of Electrical Engineering and Information Technology and the Department of Computer Science and Automation.

(7) Should a student intend to write the Master's thesis outside the university or in a group of the university not involved in the degree program, he/she shall add the following to the application for admission:

- the approval of the desired institution/company or the desired group, indicating a specialist supervisor with details and proof of his/her qualifications,
- a brief description of the task and content,
- a declaration by the supervising university professor.

(8) The supervising university professor is the first assessor/examiner of the thesis. According to § 33 para. 1 PStO-AB, the supervising professor is entitled to suggest the second assessor/examiner.

§ 15 Determination of the overall grade

The determination of the overall grade follows § 17 para. 5 sentence 1 PStO-AB.

D. Final regulations

§ 16 Validity and termination of validity

(1) These Examination and Study Regulations - Special Provisions - for the Communications and Signal Processing program leading to the degree of "Master of Science" shall be valid as of the day following their publication in the university's Official Gazette. They apply to all students enrolled as of the winter semester 2021 / 2022.

(2) As of the end of the summer semester 2024, all other examination regulations - special provisions - and study regulations for the Communications and Signal Processing program with the degree of "Master of Science" in force at the time of the validity of these regulations shall cease to apply. For students who have not completed their studies by the time these regulations expire, the current version of the Examination and Study Regulations - Special Provisions - for the Communications and Signal Processing program leading to the degree of "Master of Science" shall apply from the time these regulations expire.

Ilmenau, 5 May 2021

signed by

Univ.-Prof. Dr.-Ing. habil. Kai-Uwe Sattler

President

Annex Special admission requirements

1. The admission to the degree program Communications and Signal Processing with the degree "Master of Science" requires - despite the general and other admission requirements - the presence of the following professional qualifications, which is to be verified in the aptitude test according to § 4 of the Regulations on the Admission to Master's Degree Programs at the Technische Universität Ilmenau (MAZugO). Therefore, the aptitude test determines whether the applicant meets the special subject-specific requirements for the degree program Communications and Signal Processing with the degree "Master of Science.

2. The aptitude test shall be based on a combination of the professional qualifications listed in the following sections 3 to 6 and weighted based on scores.

3. The Master's program is based on a first professional qualification with knowledge in the following fields:

- Technical Mathematics, Calculation, Fourier Analysis,
- Linear Algebra and Matrix Theory,
- Fundamentals of Statistics and Calculus of Probability,
- Fundamentals of Programming and Numerical Methods,
- Fundamentals of Digital Signal Processing,
- Fundamentals of Signals and Systems, Communications Engineering,
- Fundamentals of Information Theory and Coding.

4. The first professionally qualifying degree according to § 67 para. 1 sentence 1 number 4 ThürHG is assessed:

a.) with 40 points in the following degree programs (with specific and in-depth knowledge of the fields listed in item 3):

- Electrical engineering and information technology with a focus on information and communication technology or
- Computer and Systems Engineering with a focus on Telecommunications Engineering and Measurement Technology

b.) with 30 points in the following degree programs (without specific, in-depth knowledge of the fields listed in item 3):

- Electrical Engineering and Information Technology with a major in Biomedical Engineering / Micro-, Nano-electronics and Electronics Technology / Automation Technology / Power Engineering,
- Media Technology,
- Computer and Systems Engineering with a major in Applied Computer Science in Technology and the Environment / Integrated Hardware and Software Systems / Medical Computer Science / Computer Science / Systems Engineering / Multimedia Information and Communication Systems,

c.) with 20 points in the following degree programs (without specific, in-depth knowledge of the fields listed in item 3):

- Other engineering or natural science degree programs.

5. In addition, the level of qualification is assessed according to the final grade of the degree program:

- very good = 30 points
- good = 20 points
- satisfactory = 10 points.

6. Furthermore, there are considered:

- A final grade of "good" or "very good" in the three subjects or subject groups relevant to the degree program:
 - a) Communications Engineering / Signal- and Systems Engineering / Information Theory,
 - b) Digital Signal Processing / Digital Image Processing and
 - c) a subject that is an essential part of the desired degree program

and

- the completion of a closely related and equivalent bachelor's thesis or a thesis with at least the grade "good"

and

- proven, qualified and closely related professional experience of at least one year.

The assessment consists of five points each. A maximum of 20 points can be earned.

7. Should the applicant achieve the following according to the assessments with reference to the sections 3 to 6:

a) The aptitude test is to be assessed as "Special access requirements met" when the total score is 70 points or more according to the presented documents.

b) The aptitude test is to be assessed as "Special admission requirements not fulfilled" if, based on the presented documents, the total score is less than 60 points (§ 4 Para. 4 Sentence 4, Para. 6 Sentence 1 MA- ZugO).

8. The responsibility for the decision according to number 1 results from § 4 para. 1 MA-ZugO. In case of doubt, the Examination Board shall decide.

Annex Curriculum

| Study segments / Modules | Module type (compulsory/ elective) | Final Module Score/Exam (Form, duration and details are defined in the module catalogues) | Semester | | | | Total LP | Weigh ting | Module description | |
|--|--|---|----------|--------------------------------------|----------|----------|-------------|---------------|------------------------|--|
| | | | 1. | 2. | 3. | 4. | | | | |
| | | | WS LP | SS LP | WS LP | SS LP | | | | |
| Mandatory Modules | | | | | | | | | | |
| Advanced Digital Signal Processing | P | MPL | 5 | | | | 5 | 5 | 200612 | |
| Information Theory and Coding | P | MPL | 5 | | | | 5 | 5 | 200667 | |
| Microwave Engineering | P | MPL | 5 | | | | 5 | 5 | 200504 | |
| Communication Networks | P | MPL | 10 | | | | 10 | 10 | 200497 | |
| Communications Engineering | P | MPL | 5 | | | | 5 | 5 | 200533 | |
| Antenna Engineering | P | MPL | | 5 | | | 5 | 5 | 200652 | |
| Advanced Mobile Communication Networks | P | MPL | | 5 | | | 5 | 5 | 200068 | |
| Mobile Communications, Complete | P | MPL | | 10 | | | 10 | 10 | 200486 | |
| Research Project | P | MPL | | 5 | | | 5 | 5 | 200488 | |
| Adaptive and Array Signal Processing, Complete | P | MPL | | | 10 | | 10 | 10 | 200484 | |
| Advanced Studies | | | | | | | | | | |
| Choice of modules worth 20 credit points according to the current elective catalogue | W | 4 MPL | | | 20 | | 20 | 20 | | |
| Key Competencies | | | | | | | | | | |
| Choice of non-technical course(s) from the department of Economy and Media (e. g. economy, law...) or ZIB. International students are encouraged to complete at least one course from the language catalogue for "Allgemeinsprache DaF" | W | MSL | | | 5 | | 5 | 0 | | |
| Master's Thesis with Colloquium | P | MPL | | | | 30 | 30 | 30 | Link | |
| Total LP | | | 30 | 30 | 30 | 30 | 120 | | | |
| | MPL | Module examination (graded) | P | Pflichtmodul / compulsory modules | | | | | | |
| | MSL | Module academic achievement (graded or non-graded) | W | Wahlmodul / elective module | | | | | | |
| | LP | Leistungspunkte / credit points | | | | | | | | |

Annex Profile description

1. Qualification goals of the Master's degree program Communications and Signal Processing

The ongoing digitization of processes is one of the most important developments of the 21st century. Data-based applications have already entered all areas of life. Therefore, the fast development of economy and society requires modern, high-performance systems for data transmission and processing. The maximum possible data transmission rates are limited by natural laws. Smart signal processing algorithms are essential to develop transmission systems approaching these limits. The Master's program in Communications and Signal Processing is designed as an in-depth program and updates students on the latest research in these fields. It is based on basic knowledge in the fields of communications engineering and signal processing, which the students gained in relevant and internationally recognized bachelor programs. The Master's degree program in Communications and Signal Processing is designed for professional and scientific specialization and is research-oriented. The completion of the Master's degree in Communications and Signal Processing represents a further university degree with professional qualifications. It provides both extensive theoretical training and practical experience with important software tools as used in industry. Professors with experience in industry designed the program to provide students with an excellent education in the fields of communications engineering and signal processing. A Master's degree from the university allows students to enter management positions, both in the field of production and in research, development and education. The program has been designed for international students who would like to gain an in-depth understanding of data transmission systems at all layers, and extensive knowledge of signal processing algorithms. The knowledge transfer covers the physical layer, including antenna and microwave technologies, as well as the application layer, including networks and multimedia systems. In addition to theoretical training, students gain practical experience through student research projects. This is an important preparation for the challenges of a professional career in this field. After graduation, students are qualified for cutting-edge research, challenging engineering jobs or technical management.

Graduates of the program will have acquired the following competencies:

Knowledge, understanding, and comprehension

Graduates have proven knowledge and understanding based on the Bachelor level, which they have substantially deepened and extended. They are able to define and interpret the specifics, scope, terminologies and academic opinions of their field of study. Graduates have gained a broad, detailed and critical understanding at the cutting edge of knowledge in the field of communications engineering and signal processing. Their knowledge and understanding provides the basis for the research-oriented development and application of independent ideas. With the inclusion of scientific and methodological considerations, graduates weigh up the technical epistemologically founded correctness of technical and practice-relevant statements against each other. They solve practice-relevant and scientific problems with the help of these considerations.

Use, application, and generation of knowledge

Graduates will be able to apply their knowledge, understanding, and problem-solving skills to new and unfamiliar situations that are broadly or multi-disciplinarily related to their field of study.

Graduates:

- integrate existing and new knowledge in complex contexts even based on limited information,
- make scientifically sound decisions and critically assess possible consequences,
- gain new knowledge and skills independently, and
- work on application-oriented projects mainly independently.

Graduates:

- outline and design research questions,
- choose specific ways of operationalizing research and justify them,
- select research methods and justify this selection, and
- explain research results and interpret them critically.

Communication and cooperation

Graduates:

- define and outline professional and appropriate solutions to problems in their field of activity and can justify these solutions in a discourse with experts and non-specialists using theoretically and methodologically sound arguments,

- communicate and cooperate with representatives of the subject area as well as with external experts in order to solve a task in a responsible manner,
- consider different points of view as well as the interests of others involved.

Scientific self-image / professionalism

Graduates:

- develop a professional self-perception based on goals and standards in professional fields within and outside academia,
- justify their own professional activities according to theoretical and methodological knowledge,
- can assess their own abilities and skills,
- autonomously consider appropriate design options and decision-making opportunities and make use of them,
- recognize the framework conditions of professional action appropriate to the situation and justify their decisions in terms of responsible ethics,
- critically consider their professional activities in terms of societal expectations and consequences.

2. Content-related main focus / course of studies / curriculum of the Master's program in Communications and Signal Processing

The program is open to applicants from all over the world. The language of instruction is English. Applicants whose native language is not English must certify excellent results in language tests for admission. The Master's thesis must be written in English.

The two-year program begins with some basic lectures to update and broaden the knowledge of students from all over the world. The students are well prepared with this background for the in-depth lectures of the second and third semesters.

The students should be motivated to deepen and work on the tasks discussed in the lectures at home. For this purpose, they are offered homework and projects from current research fields. Homework serves to illustrate results of the lectures including theoretical proofs as well as simulations using common software tools. In many cases, homework involves investigating the performance of transmission systems or extracting key parameters from measured data. Most topics covered in lectures are best learned combining simulations and theoretical analysis. Therefore, homework is an important part of the lectures.

Students can also work on the student research projects in groups, as working with other students can result in a significant gain in knowledge. The student research projects promote scientific work. In the projects, students have the opportunity to apply their knowledge gained in mathematics, natural sciences and engineering disciplines, as well as to learn working methods, skills and modern engineering tools relevant to practice. In addition to an overview of current issues, students will gain a deeper insight into the specialized field they are studying. Furthermore, they are expected to present their topics and research results, which will also be an important competence for their later career. Finally, the Master's thesis certifies that the student is able to work on a specific issue in depth. By applying the knowledge and skills gained from lectures, homework assignments and student research projects, students can work on cutting-edge research subjects. The program is unique in Thuringia. There are only a few Master's programs with English as the language of instruction and with comparable characteristics throughout Germany. Degree programs with a focus on pure data processing are more in the field of computer science and focus less on aspects of data transmission, such as the Computer Science for Digital Media program at the Bauhaus University in Weimar.

4. Demand for graduates in industry

Due to the international focus of the program, the demand for graduates depends very much on the country in which the graduates are seeking a position. Continuous further development of technologies and ever more diverse application scenarios result in a high global demand for specialists with knowledge in the areas of data transmission and data analysis and the necessary understanding of signal theory. The Labor Market Forecast 2030 published by the German Federal Ministry of Labor and Social Affairs shows that, without adjustments to the demand structure, Germany alone would have a shortage of nearly two million workers with university degrees in 2030. The forecast includes a continuing shortage in technical jobs and in the science sector.

Annex Competence goals and regulatory area elective course catalogues

The Communications and Signal Processing program with the degree of "Master of Science" includes two elective fields:

1. Elective field "Advanced Studies"

(1) In the "Advanced Studies", students deepen and broaden their knowledge in various fields of application and related areas of communications engineering and signal processing providing them with the opportunity to set and deepen their own focal points that correspond to their aptitudes and interests. Furthermore, this can serve as a preparation for the final thesis as well as a possible professional specialization.

(2) According to the curriculum (appendix), students must earn twenty credit points in this elective field.

(3) A selection of modules based on the range of courses offered in the relevant groups at the university is provided in the respective current elective catalog.

(4) According to § 3 para. 7 PStO-AB, the elective catalogue can be updated.

2. Elective field "Key Competencies"

(1) The elective field "Key Competencies" serves the purpose of gaining additional knowledge, skills, and competencies, especially in the linguistic, societal, and social fields. Students choose a module or classes from the range of classes offered in economics, law, labour, and media studies, the Studium generale, European studies and the languages offered by the university. International students are recommended to complete at least one class from the "General Language - German as a Foreign Language" program.

1. According to the curriculum (appendix), students must earn at least five credit points in the "Key Competencies" by completing graded assignments/exams.