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This is a translation of the Examination Regulations of the master's program *Embedded Systems Engineering* that were passed (in German) by the University of Freiburg Senate in its meeting on August 19, 2005 (Official Bulletins, Volume 36, No. 46, pp. 269-293) and adapted on December 17, 2018 (Official Bulletins, Volume 49, No. 64, pp. 489-516) – with amendments

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<https://www.studium.uni-freiburg.de/en/program-offerings/all-degree-programs/info/399>

Examination Regulations for the Master of Science (M.Sc.) Program

Annex B. Subject-specific Provisions for Examination Regulations for a Master of Science (M.Sc.)

Embedded Systems Engineering

§ 1 Profile of the Study Program

(1) The master's program *Embedded Systems Engineering* is research-oriented and consecutive.

(2) The internationally oriented, English-taught master's program *Embedded Systems Engineering* is aimed in particular at graduates of bachelor's programs in computer science and engineering, namely in the fields of electrical engineering, electronics and information technology. It provides in-depth knowledge in the area of design, development and application of embedded systems. This includes in particular knowledge about the design of micro-electronic, micro-mechanical and software-based components as well as their integration into an overall system, which meets optimization goals such as functionality, speed, cost, energy efficiency and reliability. Depending on their individual focus, students acquire special knowledge in the areas of Artificial Intelligence, Cyber-Physical Systems, Circuits and Systems, Materials and Fabrication, Biomedical Engineering and Photonics. They have the choice between a broad education across the entire spectrum of the departments of Computer Science and Microsystems Engineering or a specialization in one of the above-mentioned areas, which is shown in the final documents. Students will be qualified to research, develop and apply technical solutions with combined hardware-software systems in their future engineering activities. Successful completion of the master's program qualifies students for an academic career in research and development as well as engineering positions in industry, research organizations, or government agencies.

§ 2 Commencement and Scope of the Master Degree Program

(1) The master's program *Embedded Systems Engineering* can be entered either in the winter semester or in the summer semester.

(2) The master's program in *Embedded Systems Engineering* consists of coursework equivalent to 120 ECTS credits.

§ 3 Language of Instruction and Examination

(1) Courses and examinations in the master's program *Embedded Systems Engineering* are generally held in English. Individual modules and courses, which are freely selectable, and their associated examinations can also be held entirely or partly in German.

(2) With the prior consent of the person responsible for the module, the examinations can also be carried out in the other language (i.e., German or English).

(3) The modules offered in German require proof of German language skills corresponding to at least level B2 of the Common European Framework of Reference for Languages.

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§ 4 Course Contents

(1) The master's program *Embedded Systems Engineering* is divided into the area of Computer Science with the Essential Lectures in Computer Science and Elective Courses in Computer Science (paragraphs 2 and 3) and the area of Microsystems Engineering with the Advanced Microsystems Engineering and Microsystems Engineering Concentration Areas (paragraphs 4 and 5) as well as the optional area Customized Course Selection (paragraph 6). The modules that can be taken in the individual areas and the associated courses are listed and described in more detail in the respective module handbook. According to the specifications mentioned in paragraph 8, the master's program *Embedded Systems Engineering* can be studied with a specialization.

(2) In the area of Computer Science, a minimum of 36 and a maximum of 54 ECTS credits are to be earned. At least 18 ECTS credits must be acquired by completing three of the modules from the area of Essential Lectures in Computer Science listed in Table 1 below. A maximum of three further modules from the area of Essential Lectures in Computer Science can be selected from the range of courses listed in Table 1 or from the additional range of courses that can be provided for this purpose in the module handbook. The modules, which are completed with a graded assessment ("Prüfungsleistung") in the form of a written exam, have a scope of 6 ECTS credits each, and (depending on the structure of the associated courses) can also include additional coursework ("Studienleistungen").

Table 1: Area Essential Lectures in Computer Science (18 to 36 ECTS credits)

Module	Type	SWS	ECTS credits	Semester	Assessment: Coursework/ Examination
Algorithm Theory	L + E	4	6	1 or 3	CW EX: written exam
Cyber-Physical Systems – Discrete Models	L + E	4	6	1 or 3	CW EX: written exam
Databases and Information Systems	L + E	4	6	1 or 3	CW EX: written exam
Introduction to Embedded Systems	L + E	4	6	1 or 3	CW EX: written exam
Machine Learning	L + E	4	6	1 or 3	CW EX: written exam
Computer Architecture	L + E	4	6	2	CW EX: written exam
Foundations of Artificial Intelligence	L + E	4	6	2	CW EX: written exam
Image Processing and Computer Graphics	L + E	4	6	2	CW EX: written exam
Software Engineering	L + E	4	6	2	CW EX: written exam

Abbreviations in the table:

Type = type of course; SWS = planned number of semester hours per week; Semester = recommended semester; L = lecture; E = exercise; CW = coursework ("Studienleistung"); EX = examination ("Prüfungsleistung")

(3) In the area of Computer Science, a minimum of 18 and a maximum of 36 ECTS credits must also be earned by completing Specialization Courses in Computer Science, which can be selected from the range of Elective Courses in Computer Science offered by the Department of Computer Science, as described in the module handbook. The Specialization Courses in Computer Science can be offered as lectures with exercises, lectures with seminars or lectures with exercises and seminars. Depending on the content of the individual specialization courses, it may be necessary to complete additional coursework ("Studienleistungen") in addition to the graded assessment ("Prüfungsleistung"). The graded assessments in specialization courses consists of either a written or an oral examination; it is guaranteed that the students can choose between the different types of graded assessments within the framework of the courses offered

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overall.¹ In the area of Elective Courses in Computer Science, instead of Specialization Courses in Computer Science, students may also take a maximum of two seminars and a maximum of one study project from the range of courses offered by the Department of Computer Science as shown in the module handbook. The seminars, with a scope of 3 ECTS credits each, include coursework and are completed with an graded assessments in the form of an oral presentation. In a study project, which has a scope of 18 ECTS credits, coursework and a graded assessment have to be completed; depending on the topic of the respective study project, the graded assessment can consist of a written elaboration or the creation of a software or a demonstrator.

(4) In the area of Microsystems Engineering, a minimum of 36 and a maximum of 54 ECTS credits are to be earned. At least 18 ECTS credits must be acquired by completing three of the modules from the area of Advanced Microsystems Engineering listed in Table 2 below. A maximum of three further modules from the area of Advanced Microsystems Engineering can be selected from the range of courses listed in Table 2 or from the additional range of courses that can be provided for this purpose in the module handbook. The modules, which are completed with a graded assessment (“Prüfungsleistung”) in the form of a written exam, have a scope of performance of 6 ECTS credits each, and (depending on the structure of the associated courses) can also include additional coursework (“Studienleistungen”).

Table 2: Area Advanced Microsystems Engineering (18 to 36 ECTS credits)

Module	Type	SWS	ECTS credits	Semester	Assessment: Coursework/ Examination
Assembly and Packaging Technology	L + E	4	6	1, 2 or 3	EX: written exam
Micro-electronics	L + E	4	6	1 or 3	EX: written exam
Micro-mechanics	L + E	4	6	1 or 3	EX: written exam
Micro-optics	L + E	4	6	1 or 3	CW EX: written exam
Modelling and System Identification	L + E	4	6	1 or 3	CW EX: written exam
MST Technologies and Processes	L + E	4	6	1 or 3	CW EX: written exam
Sensors	L + LC	4	6	1 or 3	CW EX: written exam
Signal Processing	L + E	4	6	2	EX: written exam

Abbreviations in the table:

Type = type of course; SWS = planned number of semester hours per week; Semester = recommended semester; L = lecture; E = exercise; CW = coursework (“Studienleistung”); EX = examination (“Prüfungsleistung”)

(5) In the area of Microsystems Engineering, a minimum of 18 and a maximum of 36 ECTS points must also be earned by completing modules from the Microsystems Engineering Concentration Areas. The modules can be selected from the range of courses offered by the Department of Microsystems Engineering, as described in the module handbook. A minimum of 18 ECTS credits must be earned in one of the four Microsystems Engineering Concentration Areas Circuits and Systems, Materials and Fabrication, Biomedical Engineering and Photonics. Each module has a scope of 3, 6 or 9 ECTS credits and is completed with a graded assessment (“Prüfungsleistung”); depending on the structure of the associated courses, additional coursework (“Studienleistungen”) may also be required. It is guaranteed that the students can choose between the different types of graded assessments within the framework of the courses offered overall.²

¹ In order to explain: This means each semester there will be specialization courses offered with written exams and there will be specialization courses offered with oral exam. Students can choose the exam method by choosing an according specialization course. It does not mean students can select their preferred assessment method for a course.

² Again: This means each semester there will be Concentration courses offered with written exams and there will be Concentration courses offered with oral exam. Students can choose the exam method by choosing an according Concentration course. It does not mean students can select their preferred assessment method for a course.

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(6) Instead of doing more than the required minimum of courses in the areas of Essential Lectures in Computer Science, Elective Courses in Computer Science, Advanced Microsystems Engineering and Microsystems Engineering Concentration Areas, a maximum of 18 ECTS credits can also be earned in the optional Customized Course Selection Area. In the area of Customized Course Selection, modules can be chosen either from the courses offered by the Department of Computer Science or the Department of Microsystems Engineering, in which no graded assessments (“Prüfungsleistungen”) but only pass/fail assessments (“Studienleistungen”) have to be completed; or they can be chosen from suitable modules or courses from other programs of the University of Freiburg; a maximum of one language course from the courses offered by the departments of the Faculty of Philology and the Faculty of Humanities (courses for students of all faculties) can also be taken. The board of examiners decides on the suitability of the modules or courses from the course offerings of other programs of the University in consultation with the respective subject. In the modules from the area of Customized Course Selection, only pass/fail assessments (“Studienleistungen”) are required.

(7) In the areas Essential Lectures in Computer Science, Elective Courses in Computer Science, Advanced Microsystems Engineering, Microsystems Engineering Concentration Areas and Customized Course Selection a total of 90 ECTS credits must be earned. In the individual areas, no more courses or modules can be taken than those necessary to achieve the minimum number of ECTS credits required for the respective area and, depending on the individual focus, the proportion of the total 90 ECTS credits to be acquired that is attributable to the area in question.³

(8) If one of the six specializations Artificial Intelligence, Cyber-Physical Systems, Circuits and Systems, Materials and Fabrication, Biomedical Engineering and Photonics is chosen, modules with a total of at least 30 ECTS credits must be completed from the courses offered by the Department of Computer Science or the Department of Microsystems Engineering as specified in the module handbook for the respective specialization. In addition, the topic of the Master thesis must be chosen from the area of the selected specialization.

§ 5 Pass/fail assessments or Coursework (Studienleistungen)

Coursework or non-graded pass/fail assessments can consist, for example, of written examinations, presentations or posters, the completion of exercise sheets and project tasks or the performance of experiments.

§ 6 Graded assessments (Studienbegleitende Prüfungsleistungen)

Written graded assessments are examinations (written supervised work, “Klausuren”) and written elaborations. Oral graded assessments are oral examinations (examination discussions) and oral presentations. Practical graded assessments consist of the performance of experiments and the creation and demonstration of software or demonstrators.

§ 7 Repeat of graded assessments

(1) Assessments graded “not adequate” (5.0) or considered as failed, can be repeated once. In addition, a maximum of two failed graded assessments, which consist of a written or oral examination, can be repeated a second time.

(2) If a student fails a graded assessment in a module in the area of Computer Science or Microsystems Engineering, he/she may, instead of retaking this graded assessment, also take another suitable module once and take the graded assessment during that course. The failed examination attempt in the originally selected module must not be considered as one of the failed attempts in the newly selected module.⁴

(3) No more than one successfully completed graded assessment in the form of a written or oral examination may be retaken once for the purpose of improving the grade. The repeat examination is to be retaken on the next regular examination date and at the latest in the third semester. The graded assessment with the better grade will be considered.

³ In order to explain: After the required minimum for each of the 4 areas is subtracted from the 90 ECTS credits, 18 ECTS credits remain to be distributed over the 4 areas and the Customized Course Selection. Students have to take care not to take more courses than necessary to achieve these 18 ECTS credits.

⁴ Note: The legal wording referring to „The failed examination attempt...” means, that you can only choose to switch to another course after the **first** attempt. You can't do this anymore, if you have already taken a repetition exam. And you can do so only once overall.

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§ 8 Admission to write the Master's thesis

Only those who are enrolled in the master's program *Embedded Systems Engineering* and have successfully completed modules with a total of at least 72 ECTS credits can be admitted to the Master's thesis. Students who have been admitted to the master's program *Embedded Systems Engineering* under a condition must also demonstrate compliance with the condition.

§ 9 Master's thesis

(1) The Master's thesis must be completed within a period of six months and is worth 27 ECTS credits. If a specialization is chosen, the topic of the Master's thesis shall be selected from the specialization in question.

(2) The Master's thesis must be written in English or German.

(3) The Master's thesis shall be submitted to the Board of Examiners ("Fachprüfungsausschuss") in bound form in single copy and additionally in electronic form on the specified data carrier system in the specified file format. In the case of data or software-related work, the submission of the program code and data used may also be required.

(4) The Master's thesis is supplemented by an approximately 60-minute Master's colloquium (i.e. thesis defence), which is held in English or German depending on the student's choice. The Master's colloquium is usually led and evaluated by the supervisor of the Master's thesis and consists of an approximately 20-minute presentation by the student on the results of the Master's thesis and a subsequent discussion. Admission to the Master's colloquium will only be granted if the Master's thesis has been submitted. The Master's colloquium is worth 3 ECTS credits and is usually open to members of the university.

§ 10 Calculation of the final overall grade

(1) The final overall grade is calculated as the arithmetic average of the module grades weighted by ECTS credits.

(2) If all the module grades are "very good" – 1.3 or better – or the final overall grade is 1.0, the honors "with distinction" will be awarded.

§ 11 Subject designation with specialization supplement in the degree documents

In the case of successful completion of the master's program *Embedded Systems Engineering* with one of the six specializations according to § 4 paragraph 8, the title of the subject "Embedded Systems Engineering" shall be added to the degree certificate according to the completed specialization with the addition "Specialization Artificial Intelligence", "Specialization Cyber-Physical Systems", "Specialization Circuits and Systems", "Specialization Materials and Fabrication", "Specialization Biomedical Engineering" or "Specialization Photonics".