M.Sc. Embedded Systems Engineering (ESE)

Comparison of syllabus
Exam regulations (PO) 2012 vs.
Exam regulations (PO) 2021

+ Recommendations on when to object to the automatic transfer to the new exam regulations
### Old syllabus - Structure

<table>
<thead>
<tr>
<th>Module / Area</th>
<th>Semester</th>
<th>ECTS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kursvorlesung Informatik (&quot;advanced lecture&quot;)</td>
<td>1 or 2</td>
<td>6</td>
</tr>
<tr>
<td>Kurs- or Spezialvorlesung Informatik</td>
<td>1 or 2</td>
<td>6</td>
</tr>
<tr>
<td>Assembly and Packaging Technology (English) / Aufbau- und Verbindungstechnik (German)</td>
<td>1 / 2</td>
<td>5</td>
</tr>
<tr>
<td>Sensorik und Aktorik (German) / Sensors (English)</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Cyber Physical Systems – Discrete Models</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Microelectronics</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Modelling and system identification</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Concentrations area 1</td>
<td>1, 2 or 3</td>
<td>At least 15</td>
</tr>
<tr>
<td>Concentrations area 2</td>
<td>1, 2 or 3</td>
<td>At least 15</td>
</tr>
<tr>
<td>Personal Profile</td>
<td>1, 2 or 3</td>
<td>At least 15</td>
</tr>
<tr>
<td>Master thesis + Presentation</td>
<td>4</td>
<td>27 + 3</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>120</td>
</tr>
</tbody>
</table>

Select one = Concentration 1 (at least 15 ECTS)

Select one = Concentration 1 (at least 15 ECTS)

At least 51 ECTS

- Sensors and Actuators
- Design and Simulation
- Circuits and Systems
- Reliable Embedded Systems
- Distributed Systems
- Robotics and Computer Vision

At least 51 overall
## New syllabus – Structure

<table>
<thead>
<tr>
<th>ECTS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Essential Lectures in Computer Science</td>
</tr>
<tr>
<td>18</td>
<td>Advanced Micro-systems Engineering (MSE)</td>
</tr>
<tr>
<td>18</td>
<td>Elective Courses in Computer Science Specialization Courses (6 ECTS each) and/or up to 2 Seminars (3 ECTS each) or 1 Study project (18 ECTS)</td>
</tr>
<tr>
<td>18</td>
<td>Concentration Areas in Micro-systems Engineering</td>
</tr>
<tr>
<td>18</td>
<td>Chosen from one or more of the 4 areas above and/or from the area Customized Course Selection</td>
</tr>
<tr>
<td>30</td>
<td>Master Thesis + Colloquium</td>
</tr>
</tbody>
</table>

For optional specialization in one of the areas (AI, CPS, Circuits and Systems, Materials and Fabrication, Biomedical Engineering, Photonics): at least 30 ECTS from according courses (not project) + Master Thesis with related topic.
New structure means:

- 4 mandatory areas with 18 ECTS each
  - 2 Computer Science (Essential Lectures in CS + Elective Courses in CS)
  - 2 MSE (Advanced MSE + Concentration Area in MSE)
- Remaining 18 ECTS have to be distributed over either one or more of the above mentioned areas or the Customized Course Selection

But:

- **No more** fixed mandatory courses
- **No more** Concentration area CS + Personal Profile
<table>
<thead>
<tr>
<th>Module</th>
<th>ECTS</th>
<th>Semester (recommended)</th>
<th>Course type in PO 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm Theory (course type: advanced lecture)</td>
<td>6</td>
<td>1 oder 3</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
<tr>
<td>Cyber-Physical Systems – Discrete Models</td>
<td>6</td>
<td>1 oder 3</td>
<td>mandatory area</td>
</tr>
<tr>
<td>Databases and Information Systems (course type: advanced lecture)</td>
<td>6</td>
<td>1 oder 3</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
<tr>
<td>Introduction to Embedded Systems</td>
<td>6</td>
<td>1 oder 3</td>
<td>Specialization course Informatik/CS</td>
</tr>
<tr>
<td>Machine Learning (course type: advanced lecture)</td>
<td>6</td>
<td>1 oder 3</td>
<td>Specialization course Informatik/CS</td>
</tr>
<tr>
<td>Computer Architecture (course type: advanced lecture)</td>
<td>6</td>
<td>2</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
<tr>
<td>Foundations of Artificial Intelligence (course type: advanced lecture)</td>
<td>6</td>
<td>2</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
<tr>
<td>Image Processing and Computer Graphics (course type: advanced lecture)</td>
<td>6</td>
<td>2</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
<tr>
<td>Software Engineering (course type: advanced lecture)</td>
<td>6</td>
<td>2</td>
<td>Key course / Kursvorlesung Informatik/CS</td>
</tr>
</tbody>
</table>
# Advanced Microsystems Engineering (MSE)

<table>
<thead>
<tr>
<th>Module</th>
<th>ECTS</th>
<th>Semester (recommended)</th>
<th>Course type in PO 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly and Packaging Technology</td>
<td>6</td>
<td>1, 2 oder 3</td>
<td>mandatory area</td>
</tr>
<tr>
<td>Micro-electronics</td>
<td>6</td>
<td>1 oder 3</td>
<td>mandatory area</td>
</tr>
<tr>
<td>Micro-mechanics</td>
<td>6</td>
<td>1 oder 3</td>
<td>Personal Profile</td>
</tr>
<tr>
<td>Micro-optics</td>
<td>6</td>
<td>1 oder 3</td>
<td>Personal Profile</td>
</tr>
<tr>
<td>Modelling and System Identification</td>
<td>6</td>
<td>1 oder 3</td>
<td>mandatory area</td>
</tr>
<tr>
<td>MST Technologies and Processes</td>
<td>6</td>
<td>1 oder 3</td>
<td>Personal Profile</td>
</tr>
<tr>
<td>Sensors</td>
<td>6</td>
<td>1 oder 3</td>
<td>mandatory area</td>
</tr>
<tr>
<td>Signal Processing</td>
<td>6</td>
<td>2</td>
<td>Personal Profile</td>
</tr>
</tbody>
</table>
Elective Courses in Computer Science

You have to take courses up to at least 18 ECTS. The maximum (if you do not take more than the bare minimum 18 ECTS anywhere else) would be 36 ECTS.

You can choose from

- Specialization Courses in Computer Science (6 ECTS each)
- *And/or* up to 2 Seminars (3 ECTS each)
- *And/or* 1 Study project (18 ECTS)

*(Please be aware that you cannot surpass the 36 ECTS here or the 90 ECTS overall, so plan carefully if you intend to take the study project!)*
You have to choose one area and complete courses up to at least 18 ECTS. If you choose to take more than this, the surpassing courses can be from another area. (The maximum would, again, be 36 ECTS, if you do no courses in any other area.)

The 4 Concentration Areas are:

- **Circuits and Systems** (includes the old areas *Circuits & Systems* and *Sensors & Actuators*)
- **Biomedical Engineering** (includes the old areas Biomedical Eng. and Lab-on-a-Chip, the courses were available in the personal profile)
- **Materials and Fabrication** (includes the old areas *Design & Simulation* and Materials, courses were available in the personal profile)
- **Photonics** (courses were available in the personal profile)
Customized Course Selection

Instead of completing additional courses (i.e. more than 18 ECTS) in these 4 areas, you can take some courses (max. 18 ECTS) in the Customized Course Selection. Here, you can choose from

- Pass-or-fail courses (*Studienleistungen*) from Computer Science or MSE (like lab courses in CS, scientific writing or project management in MSE)
- One language course (esp. German courses from SLI for international students)
- Selected courses from other departments / faculties
Optional specialization

You can choose to do a specialization in your study program (which will be shown on the final documents). There are 6 specializations available:

- Artificial Intelligence (AI) (*courses see table on next slide*)
- Cyber-Physical Systems (CPS) (*courses see table on next slide*)
- Circuits and Systems (i.e. the MSE Concentration)
- Materials and Fabrication (i.e. the MSE Concentration)
- Biomedical Engineering (i.e. the MSE Concentration)
- Photonics (i.e. the MSE Concentration)

The requirements are:

- You have to take courses with **at least 30 ECTS** from the according specialization category
  (please note: study project or lab courses do not count in CS)
- You have to do a **Master Thesis** with a related topic
### Courses belonging to AI resp. CPS

#### Lectures belonging to the specialization area

**Cyber-Physical Systems**

- Advanced Lectures
  - Rechnerarchitektur / Computer Architecture
  - Softwaretechnik / Software Engineering

**Artificial Intelligence**

- Advanced Lectures
  - Image Processing and Computer Graphics
  - Foundations of Artificial Intelligence
  - Machine Learning

#### Specialization Courses

**Cyber-Physical Systems**

- Advanced Algorithms
- Automated Machine Learning
- Blockchain and Cryptocurrencies
- Cyber-Physikalische Systeme - Diskrete Modelle / Cyber-Physical Systems – Discrete Models
- Cyber-Physical Systems – Program Verification
- Einführung in Embedded Systems / Introduction to Embedded Systems
- Formale Methoden für Java / Formal Methods for Java
- Funktionale Programmierung / Functional Programming
- Hardware Security and Trust
- Quantitative Verifikation / Quantitative Verification
- Modellbildung und Systemidentifikation / Modelling and System Identification
- Numerical Optimization
- Numerical Optimal Control in Science and Engineering
- State Space Control Systems
- Test und Zuverlässigkeit / Test and Reliability
- Verteilte Systeme / Distributed Systems

**Artificial Intelligence**

- Advanced Computer Graphics
- Artificial Intelligence Planning
- Automated Machine Learning
- Bioinformatics I
- Bioinformatics II
- Computer Vision
- Dynamische Epistemische Logik / Dynamic Epistemic Logic
- Einführung in die Multiagentensysteme / Introduction to Multiagent Systems
- Information Retrieval
- Introduction to data driven life sciences
- Introduction to Mobile Robotics
- Kompetitives Programmieren
- Prinzipien der Wissensrepräsentation / Knowledge Representation
- Reinforcement Learning
- Robot Mapping
- Simulation in Computer Graphics
- Social Robotics
- Spieltheorie / Game Theory
- Statistical Pattern Recognition
Master thesis

Exam regulations 2012

- Master's module (30 ECTS) with
  - Master's thesis (27 ECTS)
  - Colloquium (3 ECTS)
    (both graded)
- Admission to thesis:
  at least 75 ECTS credits
  *(plus conditional courses from admission, if applicable)*
- Duration: 6 months

Exam regulations 2021

- Master thesis (27 ECTS) graded
- Colloquium (3 ECTS) graded
- Admission to thesis:
  at least 72 ECTS credits
  *(plus conditional courses from admission, if applicable)*
- Duration: 6 months
New rules regarding exam repetition and grade improvement

- A maximum of 2 failed courses have a third attempt (old regulations: 3 failed courses with third attempt)
- If you failed a graded assessment (Prüfungsleistung) in a Computer Science or Microsystems Engineering course, you can choose to take another course/exam instead. You can do this only once, overall. (was not possible in old regulations)
- Repeating an exam that you have passed, to improve your mark, is possible in one module you did in your first year of studies here (old regulations: two modules with complicated regulation regarding “first attempt no later than the semester scheduled in the curriculum”)
Decision: Remain or be transferred?

- The changes have different implications for individual students. Please consider your own situation and whether a change would adversely affect you. If so, **declare you want to remain in the old version** within the given time period (Deadline: Sept. 15th, 2021).

- We **expect** all students who are only missing the master thesis and one more achievement to **object to the transfer**! (Yes, this is formally necessary!).

- We **strongly recommend** that all students missing less than 18 ECTS (in addition to the Master's thesis) **object to the transfer**. *(It will be quite difficult to re-arrange all the completed courses into the new structure…)*

- We **expect** all students in their 1st or 2nd semester to **transfer** to the new regulations.

- Please note: When you switch to the new version, the ECTS credits of some modules/courses will be adjusted accordingly. *(New structure: modules have 3, 6 or 9 ECTS, not 4 or 5)*

- Previously completed Computer Science lab courses with graded assessments will be counted same as lectures with 6 ECTS, but can’t be considered for specializations!
Critical cases

- Please **object to the transfer** (as you cannot fulfill the requirements for the Essential Lectures in CS area), if in the old 2012 syllabus you have completed all required lectures in Computer Science in some other combination than
  - Either 2 key courses (Kursvorlesung)
  - Or 1 key course and either the specialization course „Machine Learning“ or „Introduction to Embedded Systems“ (no matter if you did so in the category of „Spezialvorlesung“ or as part of your Concentration in CS or as part of the Personal Profile)

- Please **object to the transfer** (as you cannot fulfill the requirements regarding the ECTS distribution to the computer science and MSE areas) if
  - You already did a Master project / study project (18 ECTS) in your Personal Profile **and**
  - Completed more than 18 ECTS by doing specialization courses, seminars or lab courses (no matter if you did so in the category of „Spezialvorlesung“ or as part of your Concentration in CS or as part of the Personal Profile)

- Carefully check the affiliation of your completed MSE course to the new Concentrations. If you can't fit 18 ECTS into one new Concentration area: Please **object to the transfer**.