M.Sc. Embedded Systems Engineering (ESE)

Comparison of syllabus

Exam regulations (PO) 2012 vs.

Exam regulations (PO) 2021

Updated April 12th, 2022 (with more information about Customized Course Selection)
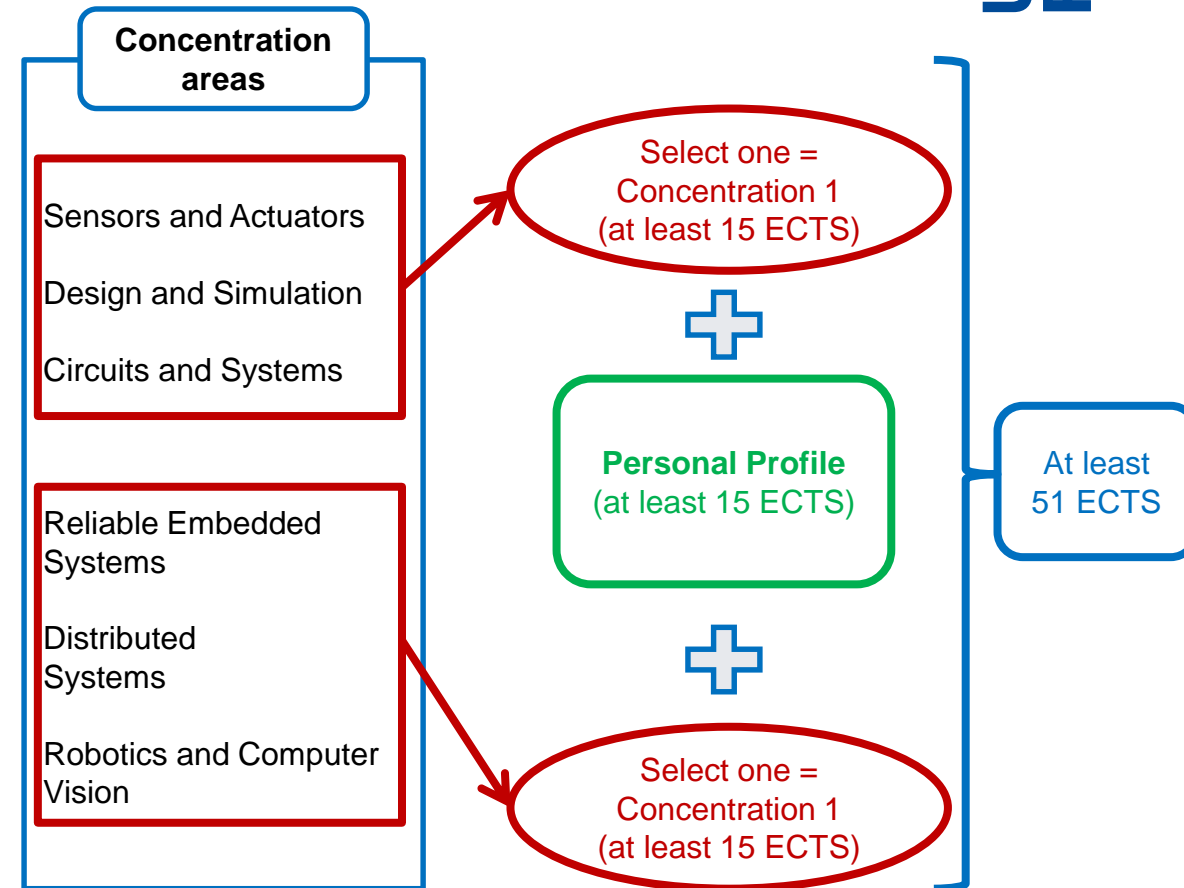
Albert-Ludwigs-Universität Freiburg

+ Recommendations on when to object to the automatic transfer
to the new exam regulations

Old syllabus - Structure

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

Concentrations area 1, Concentrations area 2, Personal Profile: At least 51 overall

Concentration areas

Sensors and Actuators

Design and Simulation

Circuits and Systems

→ Select one = Concentration 1 (at least 15 ECTS)

Reliable Embedded Systems

Distributed Systems

Robotics and Computer Vision

→ Select one = Concentration 1 (at least 15 ECTS)

Personal Profile (at least 15 ECTS)

At least 51 ECTS

New syllabus – Structure

18 ECTS (3 lectures) from **Essential Lectures in Computer Science**	**18 ECTS** (3 lectures) from **Advanced Micro-systems Engineering (MSE)**	**18 ECTS** from **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)	**18 ECTS** from **one** of the **Concen-tration Areas in Micro-systems Engineering**

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

18 ECTS chosen from one or more of the 4 areas above *and/or* from the area **Customized Course Selection**

30 ECTS Master Thesis + Colloquium

Differences old vs. new

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

Essential Lectures in Computer Science

Module	ECTS	Semester (recommended)	Course type in PO 2012
Algorithm Theory (course type: advanced lecture)	6	1 oder 3	Key course / Kursvorlesung Informatik/CS
Cyber-Physical Systems – Discrete Models	6	1 oder 3	mandatory area
Databases and Information Systems (course type: advanced lecture)	6	1 oder 3	Key course / Kursvorlesung Informatik/CS
Introduction to Embedded Systems	6	1 oder 3	Specialization course Informatik/CS
Machine Learning (course type: advanced lecture)	6	1 oder 3	Specialization course Informatik/CS
Computer Architecture (course type: advanced lecture)	6	2	Key course / Kursvorlesung Informatik/CS
Foundations of Artificial Intelligence (course type: advanced lecture)	6	2	Key course / Kursvorlesung Informatik/CS
Image Processing and Computer Graphics (course type: advanced lecture)	6	2	Key course / Kursvorlesung Informatik/CS
Software Engineering (course type: advanced lecture)	6	2	Key course / Kursvorlesung Informatik/CS

Advanced Microsystems Engineering (MSE)

Module	ECTS	Semester (recommended)	Course type in PO 2012
Assembly and Packaging Technology	6	1, 2 oder 3	mandatory area
Micro-electronics	6	1 oder 3	mandatory area
Micro-mechanics	6	1 oder 3	Personal Profile
Micro-optics	6	1 oder 3	Personal Profile
Modelling and System Identification	6	1 oder 3	mandatory area
MST Technologies and Processes	6	1 oder 3	Personal Profile
Sensors	6	1 oder 3	mandatory area
Signal Processing	6	2	Personal Profile

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!)

Please note: Lab courses no longer belong to this area (unless already completed before SS2021); they are now part of the Customized Course Selection and pass-or-fail courses only

Concentration Areas in Microsystems Engineering

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 additional 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: What it's **not**!

- The Customized Course Selection is **not** the same as the Personal Profile in the old exam regulations!

- It ist **not** the name for the 18 ECTS credits that can be distributed flexibly!

- Unfortunately, it is also **not** identical to the Customized Course Selection category in the Master in Microsytems Engineering programs (there are different rules and exam regulation)

- You do **not** take any CS or MSE lectures here, that are part of the other 4 areas here. (There is no dual affiliation for those lectures – they are part of the one category/area where you see them in the study planner.)

- There are **no** graded assessments in the Customized Course Selection.

Customized Course Selection: What it **is**!

The Customized Course Selection simply is the name of the category of courses optionally available for you that are completed with pass-or-fail assessments only.

So, instead of completing additional courses (i.e. more than 18 ECTS) in the 4 mandatory areas (2 in CS, 2 in MSE), you can take some courses from the selection here (with at most 18 ECTS).
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 (for now: individual application necessary)

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	Lectures belonging to the specialization area Artificial Intelligence
Advanced Lectures	**Advanced Lectures**
• Rechnerarchitektur / Computer Architecture • Softwaretechnik / Software Engineering	• Image Processing and Computer Graphics • Foundations of Artificial Intelligence • Machine Learning
Specialization Courses	**Specialization Courses**
• 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	• 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 • Foundation of Deep Learning • 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.**