Modul – No.		787		Mandatory
Module name		**Embedded Smart Systems**		
Module coordinator		Prof. Dr. Mario Schölzel		
Title		Embedded Smart Systems		
Title of examination		Embedded Smart Systems		
Semester		2		
Course Type	Language	Lecture including exercises		English
SWS/ ECTS/ Workload		2/1/1	5	150
Requirements for attendance		None		

1. Content and objectives

Content:

The module gives an introduction into the design and development of embedded systems that can be tailored to user specific applications. To fulfil this objective, the lectures present an overview of hardware architectures and components and their interconnection. The lectures also teach techniques for modeling HW-/SW-systems and assessing performance and power metrics of such systems:

- HW-Components for embedded systems, their architecture, and their interconnection: General Purpose Processor, Microcontroller, DSP, ASIP, FPGA, ASIC, busses, Memory-Mapped-I/O
- Design approaches and methods: Y-Chart, Top-Down, Bottom-Up, Middle-Out, Hardware-/Software-Codesign
- Power, Performance, and area profiling/estimations
- Methods and tools for synthesis: System synthesis, high-level-synthesis of HW-accelerators, FPGA design synthesis, Software-Synthesis
- Models: communicating processes, KPN, data flow graphs, SDF, Petri nets, state-based models, control flow graphs
- Tools for modeling: Ptolemy, SystemC, SystemC-TLM, FPGA-Design tool

In accompanying exercises and labs on selected topics, students will practice the use of some of the synthesis and modeling tools. They also have to explain their solutions.

Objectives:

After successful completion of the course unit, the students will:

- Know typical components and their interactions for building embedded systems
- Know and be able to apply models for specifying embedded systems at various levels of abstraction
- Be able to analyze, estimate and determine power, area and performance parameters of such systems during the design phase
- Model and develop systems with new hardware accelerators of low and medium complexity in the area of embedded systems
- Know typical tools for the design and development process
- Be able to present and discuss their solutions

Recommended Literature:

- P. Marwedel: Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things, Springer, 2021.
- De Micheli, G.: Synthesis and Optimization of Digital Circuits. – New York: McGraw-Hill, 1994
- Rajesh Kumar Gupta: „Co-Synthesis of Hardware and Software for Digital Embedded Systems“, Kluwer Academic Publishers, 1995.
- A. Jentsch: „Modeling Embedded Systems and SOC‘s – Concurrency and Time in Models of Computation“, Morgan Kaufmann, 2004.
- Daniel D. Gajski, Frank Vahid, Sinjiv Narayan, Jie Gong: „Specification and Design of Embedded Systems“, Prentice Hall, 1994.
- D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner: “Embedded System Design – Modeling, Synthesis and Verification”, Springer, 2009.
- J. Teich, C. Haubelt: „Digitale Hardware/Software-Systeme – Synthese und Optimierung“, Springer, 2010.
- R. Gessler, T. Mahr: „Hardware-Software-Codesign – Entwicklung flexibler Mikroprozessor-FPGA-Hochleistungssysteme“, Vieweg, 2007.
- Scholz, P.: Softwareentwicklung eingebetteter Systeme. Springer Verlag Berlin Heidelberg New York, 2005.

2. Methods of instructions

Lecture with integrated exercises and selected labs.

3. Requirements for attendance
No course specific requirements.
4. Usability of this module
The module is offered as mandatory course unit in the master study course „Computer Engineering for IoT Systems“ as well as elective course in other master courses of the Engineering Department.
5. Requirements for assessment
Assessment is performed as a written examination (90 minutes)
6. ECTS credits
5 ECTS credits
7. Frequency of offer
Every summer term
8. Work load
150 h of total work load, from: • 45 h of presence at lectures/exercises • 55 h of self-study • 50 h of preparation for examination
9. Duration of module
1 semester