System Design

1	Module Number	Study Program	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	13571	ASM	1	☒WS ☐SS	1 Semester	compulsory	240	8

2	Courses	Teaching and Learning Forms	Contact Time (SWS)	Contact Time (h)	Self-Study Time (h)	Language
	a) Automotive Systems Engineering	Lecture	4	60	120	English
	b) Software Engineering	Lecture	4	60		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

- … analyze automotive systems bottom-up …
- … design automotive systems top-down or middle-out …

Knowledge and Understanding

- ... know vehicle domains and their specific properties …
- … know mechatronic vehicle systems and their components …
- … know e/e architectures, bus systems and related terms …
- ... know relevant terms and fundamental principles related to automotive systems engineering …
- … know the system engineering process with relevant intermediate steps and artifacts …

Use, Application and Generation of Knowledge

Use and Transfer

- … be able to classify systems engineering within the process landscape
- … be able to describe the system in the problem and solution space and to apply procedures and methods to generate system engineering artifacts …
- … be able to create models for automotive systems and analyze them with respect to structure, performance and behavior …

Scientific Innovation

- … formalize systems engineering and system engineering artifacts …
- … enhance traceability, consistency and interoperability of system engineering artifacts …

Communication and Cooperation

- ... use formal models to communicate within development projects …
- … increase reusability and automated generation of artifacts …

Scientific Self-Conception/ Professionalism

- … be able to contribute to professional engineering of automotive systems from a methodological and a technical point of view …

Simulation and Control

1	Module Number	Study Program	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	13572	ASM	1	☒WS ☐SS	1 Semester	compulsory	240	8

2	Courses	Teaching and Learning Forms	Contact Time (SWS)	Contact Time (h)	Self-Study Time (h)	Language
	a) Microcontroller, Modelling and Simulation	Lecture + Lab	2+1	45	120	English
	b) Basic Control	Lecture	2	30		
	c) Advanced Control	Lecture	3	45		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- ... understand and know the basic methods of modelling, system simulation and control engineering
- … know how and where to use these methods in the development of automotive systems
- … build up basic control loops using a small Microcontroller (e.g. Arduino)

Use, Application and Generation of Knowledge

Use and Transfer

- ... apply physical laws to derive mathematical system models in different domains (mechanical, electrical, thermal)
- ... apply methods of system simulation and control engineering in automotive applications
- ... analyze and evaluate the behavior of automotive systems and subsystems by use of simulation results
- … develop small circuits with sensors and actuators and develop programs for Microcontroller, build up, test and calibrate control functions

Scientific Innovation

- … use simulation and control engineering methods and tools to gain new insights into automotive systems or subsystems.
- ... create and optimize the behavior of automotive systems based on system models
- … get acquainted with practical realization of the simulated problem in a microcontroller environment

Communication and Cooperation

- ... create, communicate and discuss technical information’s in the area of the course subject
- ... communicate actively within an organization and obtain information.

Scientific Self-Conception/ Professionalism

- ... justify the solution theoretically and methodically to improve development methods.
- ... reflect and assess one's own abilities in a group comparison.

4	**Contents**
	Lecture a): Automotive Systems Engineering
	• Introduction to Systems Engineering
	• Quick reference to Automotive Systems including:
	  ○ application domains powertrain, chassis, body, advanced driver assistance, infotainment
	  ○ mechatronic vehicle systems and their components
	  ○ E/E architecture, automotive bus systems, communication protocols
	• Systems Engineering in the Process Landscape
	• System Theory and Formalization
	• Methodologies
	• Examples
	
	Lecture b): Software Engineering
	• Introduction to Software Lifecycle Models
	• Agile Software Engineering
	• Requirements Engineering
	• Model-based Software Engineering with UML
	• Software Quality Assurance
	• Versioning Control and Configuration Management
	• Software Architecture
	• Software Design
	• Clean Code
	• Continuous Integration and Delivery

5	**Participation Requirements** compulsory: - recommended: a) Simulink, Simscape and Stateflow Onramp Courses offered from Mathworks. b) Familiarity with one of the major programming languages, C/C++ preferred.
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 min
7	**Further Use of Module** Autonomous Systems, Propulsion Systems , Team Project, Master Thesis
8	**Module Manager and *Full-Time Lecturer*** Prof. Dr.-Ing. R. Schuler, *Prof. Dr.-Ing. M. Röhricht*
9	**Literature** • J. Schäuffele, T. Zurawka: Automotive Software Engineering. Springer, 2016 • R. Isermann, Mechatronic Systems - Fundamentals, Springer, 2005 • R. Isermann, Automotive Control, Springer, 2022 • I. Sommerville, Software Engineering, Pearson, 2015
10	**Last Updated** 06.12.2023