MODULHANDBUCH

für den Studiengang der
Fakultät Mobilität und Technik

Automotive Systems (Master) – SPO 2.0

Fassung 1.0
Stand 30.11.2022

Gültig ab Wintersemester 2023/2024

Änderungsverzeichnis

Datum	Version	Beschreibung der Änderung	Bearbeiter
30.11.2022	1.0	Modulbeschreibungen	Oberhauser

Hinweis zur Gültigkeit

Dieses Modulhandbuch gilt für Studierende, die das Studium im Studiengang

- Automotive Systems SPO 2.0

der Studien- und Prüfungsordnung der Hochschule Esslingen ab dem WS23/24 aufgenommen haben.

Sonstige Anmerkungen

Der Workload pro Creditpoint beträgt in diesen Studiengängen (§8 (1) MRVO):

Credits	Workload in Stunden
1	30

Freigabe

Dieses Dokument ist freigegeben.

gez. Prof. Mathias Oberhauser

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Module erstes Semester

Mathematical Methods

1	**Module Number** 3901	**Study Programme** ASM	**Semester** 1	**Offered in** ☒WS ☐SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** -8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Numerical Analysis		Lecture		3	45	120	English
	b) Numerical Differential Equations		Lecture		2	30		
	c) Statistics and Kalman Filter		Lecture		3	45		
						[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... explain the basic ideas of numerical analysis and understand the relation to the applications
- ... understand the algorithms and their constraints
- ... understand the limitations of the algorithms

Use, Application and Generation of Knowledge

Use and Transfer

- ... apply the algorithms in MATLAB.
- ... analyse the solutions concerning plausibility.
- … recognize and classify connections.
- ... analyse technical problems and derive or develop solutions.
- ... familiarize themselves with new ideas and topics based on their basic knowledge.

Scientific Innovation

- … use methods and tools to gain new insights in the field of numerical analysis.
- ... create new models.
- ... optimize systems.
- ... independently develop approaches for new concepts and assess their suitability.
- ... develop concepts for the optimization of technical applications.

Communication und Cooperation

- ... interpret the results of numerical analysis and draw admissible conclusions.
- ... use the learned knowledge, skills and competences to evaluate the field and interpret them according to other aspects.
- ... communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- ... justify the solution theoretically and methodically.

4 **Contents**

Lecture a)

- Linear systems
- Regression
- Numerical differentiation and integration
- Nonlinear equations and nonlinear systems

Lecture b)

- Ordinary differential equations (Runge-Kutta methods, stability and stiffness, shooting methods, applications)
- Partial differential equations (finite difference methods, finite element methods, applications)

Lecture c)

	• Descriptive and inferential statistics • Probability theory • Kalman filter Programming in MATLAB as part of the lecture.
5	**Participation Requirements** compulsory: - recommended: Good knowledge of further mathematics
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination, 120 minutes
7	**Further Use of Module** Applying mathematical methods in other lectures and major fields of automotive engineering
8	**Module Manager and Full-Time Lecturer** Prof. Dr. J. Gaukel, Prof. Dr. M. Stämpfle, Prof. Dr. G. Schaaf
9	**Literature** • Gander W., Gander M.J., Kwok, F., Scientific Computing • Stanoyevitch, Introduction to Numerical Ordinary and Partial Differential Equations Using MATLAB, Wiley • Marchthaler, Dingler: Kalman-Filter: Einführung in die Zustandsschätzung und ihre Anwendung für eingebettete Systeme • Chui, Chen: Kalman Filtering, Springer
10	**Last Updated** 06.10.2022

System Design

1	Module Number	Study Programme	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	3902	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 System and Software Architectures	Lecture	4	60	120 [bitte nur Summe eintragen]	English
	b) Automotive Systems Development Process and System Test	Lecture	4	60 [1 SWS = 15h]		

3 **Learning Outcomes and Competences**

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

- … analyze automotive E/E (electronic/electric) architectures and the associated hardware and software architectures
- … develop own solutions in this application domain
- .. . work in a larger interdisciplinary engineering team based on a clear understanding of the required design and development processes necessary.

Knowledge and Understanding

- ... understand the architecture of automotive electric and electronic systems and their development process.
- … know the limits of existing systems, have an idea about future trends in the automotive E/E domain and about the problems to be solved in the future.

Use, Application and Generation of Knowledge

Use and Transfer

- ...understand the complete automotive system development process including system test and application.
- ...see the difference between systems, functions and components and their respective development processes.
- ... analyse the structure of distributed automotive electronic systems, their software architectures and the communication principles and channels.
- ... be able to analyze communication protocols, especially bandwidth and latency.
- ... be able to assess the safety and reliability of systems.
- … compare automotive solutions with solutions and concepts from other technical domains.

Scientific Innovation

- … use methods and tools to gain new insights.
- ... create models for automotive systems and use them for implementation and tests.
- ... optimize automotive E/E architectures with respect to functionality,safety, performance, robustness and cost.
- ... set up and evaluate hypothesis tests and design procedures to verify and validate the E/E design.
- ... independently develop approaches for new systems and assess their suitability, especially transfer related technical concepts and solutions from other technical fields, e.g. aerospace or computer science into the automotive domain.

Communication und Cooperation

- ... communicate actively within an organization and obtain information.
- ... interpret the results of the [field] and draw admissible conclusions.
- ... use the learned knowledge, skills and competences to evaluate E/E concepts and assess their features.
- ... present automotive system design related topics and discuss them.
- ... communicate and cooperate within an engineering team in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- … analyze the impact of design decisions on the social and economic situation of the society and derive recommendations for decisions from a social and ethical perspective on the basis of the analyses and evaluations made.
- ... justify the solution theoretically and methodically.
- ... reflect and assess one's own abilities in a group comparison and develop strategies to improve them.

4	**Contents** Lecture a): System Development • Typical components and functions of automotive systems. • Typical engine management system and its development process. • Software life cycle including classic V model, agile (Scrum) development and Automotive Spice. • Requirements engineering and requirements management. • SW-documentation and data specification, coding guidelines. • Software and system test. • Application examples of simple functions Lecture b): • Application domains powertrain, chassis, body, advanced driver assistance, infotainment, outlook to automated driving • Basics of distributed systems. ECU hardware requirements and structure, communication relations and communication problems under real-time constraints. • E/E architecture of hybrid and electric powered cars vs. cars with classic combustion engines. Trend towards domain controller and compute-server-architectures. • Automotive bus systems and communication protocols (CAN, LIN, FlexRay, MOST, Automotive Ethernet, V2X). Message based communication vs. service oriented communication. • Diagnosis and diagnostic communication. • Qualitative and quantitative assessment of system safety and reliability. Functional safety including ISO 26262. • ECU software architecture and software standards (AUTOSAR Classic and Adaptive) The lectures will include theory, case studies, literature surveys and presentation of selected topics done by student teams.
5	**Participation Requirements** compulsory: - recommended: Basic knowledge in electronics and computer science. Familiarity with one of the major programming languages, C/C++ preferred. Own experience in self-management of a project, i.e. Bachelor thesis
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. W. Zimmermann
9	**Literature** • J. Schäuffele, T. Zurawka: Automotive Software Engineering. Springer-Vieweg. • H. Wallentowitz, K. Reif: Handbuch Kraftfahrzeugelektronik. Springer-Vieweg. • R.K. Jurgen. Automotive Electronics Handbook. McGraw-Hill. • W. Zimmermann, R. Schmidgall: Bussysteme in der Fahrzeugtechnik, Springer-Vieweg. • K. Reif (Publisher): Bosch Automotive Handbook Series. Springer-Vieweg.
10	**Last Updated** 2022-10-10

Simulation and Control

1	**Module Number** 3903	**Study Programme** ASM	**Semester** 1	**Offered in** ☒WS ☐SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** 8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Microcontroller, Modelling and Simulation		Lecture + Lab		2+1	45 30	120	Englisch
	b) Basic Control		Lecture		2	45		
	c) Advanced Control		Lecture		3	[1 SWS = 15h]		

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
- ... analyse and evaluate the behaviour 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 behaviour of automotive systems based on system models
- … get acquainted with practical realization of the simulated problem in a microcontroller environment

Communication und 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**

1. Microcontroller, Modelling and Simulation (2h)

- Systematic System Modelling and Identification in different domains (mechanical, electrical, thermal)
- Adding sensors and actuators to the modelled system to get the complete transfer function
- Integration of Control loops to manage system control and dynamics

- Linearization of sensors / actuators or models (practical example)
- Do Simulations using Simulink and Simscape and evaluate results
- Build up small control system examples in Hardware and transfer control algorithm to a Real-Time Environment and do AutoCoding (Simulink to Arduino)
- Compare pure Simulink/Simscape Simulation with the System realized in Hardware with Microcontroller

BasicControl (2h)

System Representation of SISO Systems (e.g. LDE, Transfer functions, Block diagrams)

- Basic principles of open loop and closed loop feedback control

	• Elements of control loops • Linearization of nonlinear differential equations • Laplacetransformation (Definition,rules,examples) • Basic Controllers (PID) • Bode diagramm • Stability, Nyquist criteria, amplitude margin, phase edge • Root locus **2. Advanced Control I** (3h) • Linear and non-linear State Space Representation • State Space Controller Design (Pole Placement) • Observer Design and Separation Theorem • Digital Control / Discrete State Space Design • LQR-Controller Design • Diskretisierung, Matrix Exponentionalfunktion • **3. Computer Lab (1h)** • System Representations using Matlab/Simulink, Numerical Simulation • Modelling/Identification and Controller Design of an Electric Drive System • Controller Design of an Electric Drive System • System Modelling and Simulation of State Machines → System Design
5	**Participation Requirements** compulsory: Mathematics, Physics, Mechanics , Control Engineering Basics recommended: Basics in Matlab/Simulink
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination, 120 minutes
7	**Further Use of Module** Autonomous Systems, Propulsion Systems, Team project, Master Thesis
8	**Module Manager and Full-Time Lecturer** Prof. Dr.-Ing. Walter Lindermeir , Prof. Mathias Oberhauser, Prof. Georg Mallebrein
9	**Literature** • Lecture Notes and Scripts • Ogata, K.: Modern Control Engineering, Pearson Verlag • Liu, Xiangjie: Systems Control Theory, Science Press Beijing • Palm, W. J.: MATLAB for Engineering Applications, McGraw-Hill • Hanselman D.C., Littlefield B.: Mastering Matlab, Pearson Verlag • Dabney, J.B.; Harman, T.L.: Mastering Simulink • Mohthari: Engineering Applications in Process Control, Fuzzy Control
10	**Last Updated** 18.10.2022

IT Fundamentals

1	**Module Number** 3905	**Study Program** ASM	**Semester** 1	**Offered in** X WS SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 180	**ECTS Points** 6

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Data Structures and Algorithms	Lecture	3	45	90	English
	b) Programmable Systems and Networks	Lecture	3	45		
				[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- … explain the architecture and workings of a modern computer
- … understand the representation of items as data in computers
- … explain the working of an operation system
- … explain the challenges and solutions for communication between computers

Use, Application and Generation of Knowledge

Use and Transfer

- … design an algorithm for a specific task
- … implement an algorithm efficiently in an imperative programming language (C, Python)
- … analyse the complexity of an algorithm
- … choose a data structure suitable for a specific task
- … analyse network communication
- … choose types of network communication for a specific task
- … consider the architecture of the computer and the operating system to implement a distributed system

Scientific Innovation

- … use methods and tools to gain new insights in the field
- ... create software solutions to task at hand

Communication and Cooperation

- ... communicate actively within the lectures and obtain information.
- ... present technical contents and simulation results and discuss them with the class and the lecturer.
- ... communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- ... present and justify the solution to given tasks theoretically and methodically
- … take ideas and suggestions from other source into consideration

4 **Contents**

a) Lecture: Data Structures and Algorithms

- Number theory
- Graph theory
- Notation, design and classification of algorithms
- Data structures: arrays, lists, sets
- Complexity, efficiency, computability, O-notation
- Search and sort algorithms

	• Programming in C • Programming in Python b) Lecture: Programmable Systems and Networks • Number and character encoding (range, resolution, overflows) • Architecture of computers • Architecture of CPU, memory and inputs/ouputs • Overview of structure and tasks of an operation system • Types of operation systems • Processes and threads • Memory management • Interprocess communication and synchronisation • File systems • Program execution • Network fundamentals and architectures • Addressing, media access (Ethernet, WLAN) • Local networks (IP) • Routing in networks • Transport protocols (TCP, UDP) • Application protocols
5	**Participation Requirements** **Compulsory:** • none **Recommended:** • Discrete mathematics • Basics of some programming language • Computer handling
6	**Examination Forms and Prerequisites for awarding ECTS Points** Written Examination 120 Minutes
7	**Further Use of Module** Automotive Communication Usability and Dependability
8	**Module Manager and Full-Time Lecturer** NN, NN
9	**Literature** - Brian W. Kernighan and Dennis M. Ritchie: The C Programming language, Prentice Hall, 2000 - Randal E. Bryant, David R. O'Hallaron: Computer Systems A Programmer's Perspective, Pearson, 2015 - Andrew S. Tanenbaum and Herbert Bos: Modern Operating Systems, Pearson, 2014 - James Kurose and Keith Ross: Computer Networking, Pearson, 2021
10	**Last Updated** 12.10.2022

Pflichtmodule zweites Semester

Autonomous Systems

1	**Module Number** 3906	**Study Programme** ASM	**Semester** 2	**Offered in** WS XSS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** 8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Mobile Robotics		Lecture		4	60	120	Englisch
	b) Sensors		Lecture		2	30	[bitte nur Summe eintragen]	
	c) Data Fusion		Lecture		2	30		
						[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students will be able to design, implement and evaluate autonomous systems, especially in the fields of mobile robotics and self-driving vehicles.

Knowledge and Understanding

The students

- understand sensor principles and sensor signal processing
- understand how to retrieve situation understanding from sensor data
- know the most important components of a mobile autonomous system, their requirements and their mode of operation

Use, Application and Generation of Knowledge

Use and Transfer

- … apply fundamental techniques and algorithms to fuse raw signals of different sensors
- … apply fundamental techniques and algorithms of a mobile robotics software system
- … analyze and develop solutions to real-world problems

Scientific Innovation

- … develop novel approaches using state of the art statistics and filtering methods
- … develop novel approaches using state of the art machine learning methods, e.g. deep neural networks

Communication und Cooperation

- ... communicate actively within a development team with engineers from other disciplines
- ... present technical contents and discuss them

Scientific Self-Conception/ Professionalism

- … design and implement software algorithms as part of a project team
- … evaluate different sensor configurations and autonomous driving system architectures

4 **Contents**

Lecture: Mobile Robotics

- Introduction to mobile robotics and automated driving
- Machine learning and sensor-based environment perception
- Mapping and localization
- Action and motion planning
- Design and architecture of mobile autonomous systems

Lecture: Sensors

- Sensor Technology (Radar, Lidar, Camera)
- Sensor Raw Data
- Data Sets

	Data Fusion • Introduction object tracking • Basics Statistics, Kalman filter (KF) an application for automated driving • From sensor data to tracked objects, e.g. Point cloud data, segmentation and clustering
5	**Participation Requirements** compulsory: no recommended: undergraduate course in physics undergraduate course in computer science, programming in C/C++ or Python module ASM 3901 (Mathematical Methods in Engineering) module ASM 3902 (Simulation and Control)
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 Min
7	**Further Use of Module** Master Thesis
8	**Module Manager and Full-Time Lecturer** Prof. Dr. Ralf Schuler, Prof. Dr. Markus Enzweiler, Prof. Dr. Clemens Klöck, NN
9	**Literature** Sebastian Thrun et al.: Probabilistic Robotics. MIT Press, 2005. Richard Szeliski.: Computer Vision: Algorithms and Applications, 2022. RaJ, A. (Jun 28, 2002). Euclidean Clustering for Lidar point cloud data. RaJ, A. (Jun 6, 2002). 3D RANSAC Algorithm for Lidar PCD Segmentation. Maybeck, P.S. (1979). Chapter 1, "Introduction" from STOCHASTIC MODELS, ESTIMATION, AND CONTROL, Volume 1. Academic Press, 1979.
10	**Last Updated** 05.10.2022

Team Project

1	**Module Number** 3907	**Study Programme** ASM	**Semester** 2	**Offered in** WS X SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** 8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
	Team Project		Project work		**(SWS)** ~~3~~ 1	**(h)** ~~45~~ 15 [1 SWS = 15h]	**(h)** ~~165-225~~	Englisch

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... develop a project plan
- ... split complex tasks into subtasks.
- ... apply the knowledge from lectures and labs on a real application.
- ... understand the limitations of project time and human resources.

Use, Application and Generation of Knowledge

Use and Transfer

- ... use methods and tools of project management.
- ... understand the principles of systems engineering.
- … work with state of the art engineering software and measurement equipment.

...

Scientific Innovation

- ... describe interfaces of complex systems.
- ... apply scientific methods to solve industrial problems.
- … discuss pros and cons of new solutions in a group.
- … interpret measurement data and simulation results.

Communication und Cooperation

- ... work together according to a project plan
- ... take into account cultural differences in working style, leadership and communication.
- ... cooperate within the group in order to find adequate solutions for the project task.

Scientific Self-Conception/ Professionalism

- ...work successfully in international development groups in industry.

4 **Contents**

- application of project management
- constitution of hierarchy (project-manager, teams members)
- constitution of project structure (time schedule, work packages
- realisation of given task
- documentation and evaluation of results
- presentation of results
- project feedback

5 **Participation Requirements**

compulsory: -

recommended: Lectures and labs of first semester

6	**Examination Forms and Prerequisites for Awarding ECTS Points** Presentation in a group , 20 minutes Group report
7	**Further Use of Module** Preparation for Master thesis
8	**Module Manager and Full-Time Lecturer** Prof. Mathias Oberhauser
9	**Literature** •
10	**Last Updated** 10.10.2022

Wahlmodule Vertiefung Vehicle Systems

Ride and Handling

1	**Module Number** 3910	**Study Programme** ASM	**Semester** 2	**Offered in** WS XSS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 240	**ECTS Points** 8
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Handling		Lecture		4	60	120	Englisch
	b) Transmission Control		Lecture		4	60 [1 SWS = 15h]	[bitte nur Summe eintragen]	

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... develop an understanding of theory and methods in vehicle dynamics, with the focus on ride and handling properties
- ... estimate the effect of changing model parameters on ride and handling criteria

Use, Application and Generation of Knowledge

Use and Transfer

- ... analyze the performance characteristics for ride and handling

Scientific Innovation

- … apply scientific tools to the development of computer simulation models

Communication und Cooperation

- ... work together with electronic and software experts in the field of chassis control
- ... discuss new solutions for suspension systems with design engineers
- ... present technical contents in the field of suspension and handling technology and discuss them.

Scientific Self-Conception/ Professionalism

- *... justify the solution theoretically and methodically.*

4 **Contents**

c) Lecture Handling

terminology of vehicle handling, control loop ”driver-vehicle-environment”, demands on vehicle handling, planar kinematics of vehicle motion, linear (bicycle) model, under- and oversteer, steady state and transient test procedures, handling characteristics under normal driving conditions, analysis and discussion of vehicle dynamics and vehicle handling including a des- cription of the tire, nonlinear model, yaw velocity damping characteristics, effects of design parameters and the road/tire friction coefficient on handling performance

d) Lecture Suspension Modeling

terminology in multibody dynamics, kinematics of free bodies, force and tor- que elements, play and friction, Newton-Euler equations, constraint functi- ons, joints and linkages, flexible bodies, structure and functionality of multi- body codes, types of analysis, introduction into MSC.ADAMS, application in suspension modeling and simulation for ride, handling on uneven roads, and load case generation for durability

Lab projects: development of a simple multibody simulation blockset in Si- mulink, modeling and analysis of double wishbone and McPhersion suspen- sions in MSC.ADAMS, full vehicle simulations in MSC.ADSAMS/Car

5 Participation Requirements

	compulsory: no recommended: undergraduate course in mechanics (especially planar kinematics and kinetics of rigid bodies) fundamentals of automotive engineering including principles of chassis de- sign linear algebra including fundamental matrix calculus and eigenvalues Modul 103 Simulation and Control 1
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 Minutes
7	**Further Use of Module** Master Thesis
8	**Module Manager and Full-Time Lecturer** Prof. Thomas Schirle
9	**Literature** Schindler, E.: Fahrdynamik – Grundlagen des Lenkverhaltens und ihre Anwendung für Fahrzeugregelsysteme. expert verlag, 2007 Gillespie, T.D.: Fundamentals of Vehicle Dynamics. SAE Wong: Theory of Ground Vehicles. SAE Nikravesh, P. E.: Computer-Aided Analysis of Mechanical Systems. Prentice Hall 1988 MSC: ADAMS Documentaion and Tutorials
10	**Last Updated** 15.06.2019

Propulsion Systems

1	**Module Number** 3911	**Study Programme** ASM	**Semester** 2	**Offered in** ☐ WS ☒ SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload** 180 h	**ECTS** 6
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Control of electrical and electrified Powertrains (Comb. Eng./EM/Hybrid)		Lecture / Exercise		3	45	90	English
	b) Operating Strategies of electrical and electrified Powertrains		Lecture / Exercise Seminar		2	30		
	c) Seminar Powertrain Simulation				1	15		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

a) Control of electrical and electrified powertrains
- …understand the function and construction of modern combustion engine control systems
- …know about torque based system structure, air-, fuel- and ignition paths
- …know and understand the possibilities of distribution of torque/power in hybrid powertrains
- …understand and explain the scope of functions for recuperation in electrified powertrains
- …understand the functionality of power electronic actuators

b) Operating strategies of electrical and electrified powertrains
- …identify and explain operating modes of hybrid vehicles
- …know and present operating modes of various powertrains
- …understand and evaluate operating strategies of electric- and hybrid vehicles in detail
- …understand the interaction of components in the powertrain system to optimize consumption and emissions

c) Seminar powertrain simulation
- …understand structure and functionality of powertrain simulation models

Use, Application and Generation of Knowledge

Use and Transfer

a) Control of electrical and electrified powertrains
- … design control of e-drives for electric and hybrid vehicles
- … evaluate concepts of electric drives
- … compare fuel consumption with different loads, speeds, ignition timings
- … calculate resulting speeds, torques, and powers for different powertrain types
- … based on the basic knowledge of common drive components, evaluate new drive structures in terms of evaluate essential properties such as performance, smoothness, package or costs

b) Operating strategies of electrical and electrified powertrains
- …design and optimize operating strategies for different hybrid structures
- …recognize concept-related restrictions and evaluate operating quality
- …compare different operating strategies and evaluate them with regard to consumption, emissions, efficiency and range

c) Seminar powertrain simulation
- … make use of simulation tools to represent and evaluate interactions in drive systems

Scientific Innovation

a) Control of electrical and electrified powertrains
- … create some software, functions for drives and discuss how they work

Pflichtmodule drittes Semester

Softskills

1	**Module Number** 3914	**Study Programme** ASM	**Semester** 1	**Offered in** WS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 210	**ECTS Points** 7
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	a) Global Engineering		Lecture		2	45	105	Englisch
	b) Project Management		Lecture		2	45		
	c) International Negotiations		Lecture		2	45		
						[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... understand sales & marketing aspects of global engineering projects.
- … understand different approaches towards global engineering projects (waterfall, agile, hybrid project management).
- … develop a project plan, split complex tasks into subtasks.
- ... apply the knowledge from lectures and labs on a real application.
- ... understand the limitations of project time and human resources.
- … know about Intellectual properties and patent topics in engineering
- … know cultural differences.
- … improve language and mimic as a tool of successful interaction
- … understand mechanisms of multilateral business and trade formals

Use, Application and Generation of Knowledge

Use and Transfer

- ... be able to choose the right right engineering approach in relation to the market needs
- … use methods and tools of project management.
- ... understand the principles of Global Engineering.
- … interpret gantt-charts, calculate the time and financial aspects of projects.
- … include and consult IP and patent experts in a professional manner – and know when appropriate
- … use state-of –the-art software support for projects
- … apply the gained knowledge to case-studies.
- … improve cooperation within your own unit / company
- … improve company - customer relationships
- … come to better results with international partners
- … being able to estimate the economic impact of IPR
- … transfer engineering results to production

...

Scientific Innovation

- ... describe the dependency of R&D, production, sales & finance of projects.
- ... apply scientific methods to solve engineering tasks.
- … discuss pros and cons of different project management approaches.

Communication und Cooperation

- ... work together according to a project plan
- ... take into account cultural differences in working style, leadership and communication.
- ... cooperate within diverse international groups in order to find adequate solutions for the project task.
- … lead project teams
- … achieve more satisfying business output of international negotiations

	• … use the right negotiation options according to the specific (cultural) counterparts • … handle difficult situations and settle conflicts peacefully **Scientific Self-Conception/ Professionalism** • ...work successfully in international development groups in industry.
4	**Contents** **a) and b) (Global Engineering & Project Management)** • Sales & Marketing Aspects of Engineering Projects - Project lifecycle and analysis - Branding - Key Account Management - Customer Management - Bid management • Intellectual Property and Patents - Basics of Intellectual Property Rights (IPR) - Global Corporate Patent Strategy and Management - Company examples • Classical Project Management - Project Management Processes - Functions and responsibilities of a project manager - Scope, Time, Quality & Risk Management - Communications, HR & Integration Management - Documentation, reporting, presentation, decision making • Agile and Hybrid Project Management - Overview of different agile methods - Scrum - Integration of classical and agile methods • Critical Chain Project Management (CCPM) - Gamification with theoretical inputs - application of project management to a case study • Supporting IT structures - IT Network and Infrastructure - IT Organisation - IT Security - Managing Product Data - From Engineering to Production **c) International Negotiations** • Background teaching of cultural differences • Interactive / international role plays • Exchanging of experiences of business and other cross-cultural transactions and achievements / failures. • Discourse and examples aimed at improving individual skills / arguments. • Win-win situations – learning different methods of negotiations
	Participation Requirements • compulsory: - • recommended: Negotiation English Some basic business experience Basic multicultural skills
6	**Examination Forms and Prerequisites for Awarding ECTS Points** 120 min written exam
7	**Further Use of Module** Module Team Project, Preparation for Master thesis, Preparation for negotiations in job situations
8	**Module Manager and Full-Time Lecturer**

	Prof. Dr. Siegfried Zürn - plus external experts and lecturers
9	**Literature** • Script and case studies will be provided in electronic format • PMBOK Guide 8th edition, PMI Institute • Larson, E.W.; C.F. Gray (2016): Project Management – The Managerial Process, McGraw-Hill • Mühlen, Alexander (2010): International Negotiations, Münster Verlag,2010
10	**Last Updated** 2022-10-10

Master Thesis

1	**Module Number** 3915	**Study Programme** ASM	**Semester** 3	**Offered in** X WS SS	**Duration** 1 Semester	**Module Type** compulsory	**Workload (h)** 690	**ECTS Points** 23
2	**Courses**		**Teaching and Learning Forms**		**Contact Time**		**Self-Study Time**	**Language**
					(SWS)	**(h)**	**(h)**	
	Master Thesis Master Thesis Presentation and Defence		Thesis Presentation		2 1	30 15	600 45	Englisch

3 Learning Outcomes and Competences

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

Knowledge and Understanding

- ... handle and solve a problem with scientific methods on their own

..**Use, Application and Generation of Knowledge**

Use and Transfer

- ... do scientific literature research .
- … write a scientific report.
- … give a presentation about thesis results.
- … organize themselves.

...

Scientific Innovation

- ... understand the theories and their limitations in there engineering discipline.
- ... find new solutions.

...

Communication und Cooperation

- ... give comprehensive intermediate reports to supervisors.
- ... work together with technical staff in industrial labs.
- ... cooperate within their own department and other departments and suppliers.

Scientific Self-Conception/ Professionalism

- ...work in R&D departments in industry
- … join a PhD program

4 Contents

- constitution of project structure (time schedule, work packages)
- realisation of given task with scientific methods and within a given timeframe
- documentation and evaluation of results
- presentation and defense of results

5 Participation Requirements

compulsory: -

recommended: Lectures and labs of first and second semester, team project

6 Examination Forms and Prerequisites for Awarding ECTS Points

Presentation and and oral examination , 30 minutes

Thesis report

7	**Further Use of Module** Preparation for Master thesis
8	**Module Manager and Full-Time Lecturer** Prof. Mathias Oberhauser
9	**Literature** •
10	**Last Updated** 23.04.2019