Modul ASM 3901 – Mathematical Methods in Engineering

1	**Module Number** 3901	**Study Programme** ASM	**Semester** 1	**Offered in** XWS ☐SS	**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) Numerical Analysis		Lecture		4	60	105	Englisch
	b) Numerical Differential Equations		Lecture		3	45		

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
- Nonliniear equations and nonlinear systems
- Interpolation

Lecture b)

- Ordinary differential equations (Runge-Kutta methods, multistep methods, stability and stiffness, shooting methods)
- Partial differential equations (finite difference methods, finite element methods)
- Programming in Matlab as part of the lecture.

5 **Participation Requirements**

compulsory: -

recommended: Good knowledge of higher mathematics

Modul ASM 3901 – Mathematical Methods in Engineering

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
9	**Literature** • Gander W., Gander M.J., Kwok, F., Scientific Computing • Stanoyevitch, Introduction to Numerical Ordinary and Partial Differential Equations Using MATLAB, Wiley • Hairer, Norsett, Wanner: Solving Ordinary Differential Equations I, II, Springer • Smith: Numerical Solution of Partial Differential Equations: Finite Difference Methods, Oxford University Press
10	**Last Updated** 18.03.2019

Modul ASM 3902 – System Design

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3902	ASM	1	XWS ☐SS	1 Semester	compulsory	240	8

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Automotive System and Software Architectures	Lecture	4	60	120	English
	b) Automotive Systems Development Process and System Test	Lecture	4	60		

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 and 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.

Modul ASM 3902 – System Design

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** 3909 Reliable Embedded Systems 3911 Powertrain 3912 Electric and Electronic Architecture
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** 02.05.2019

Modul ASM 3903 – Simulation and Control 1

1	Module Number	Study Programme	Semester	Offered in	Duration	Module Type	Workload (h)	ECTS Points
	3903	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) Basic Control	Lecture	3	45	120	Englisch
	b) Advanced Control	Lecture	3	45		
	c) Lab Simulation and Control 1	Lab	2	30		

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 system simulation and control engineering
- … know how and where to use these methods in the development of automotive systems

Use, Application and Generation of Knowledge

Use and Transfer

- ... apply physical laws to derive mathematical system models in automotive applications
- ... apply methods of system simulation and control engineering in automotive applications
- ... analyse and evaluate the behaviour of automotive systems by use of simulation results

Scientific Innovation

- … use simulation and control engineering methods and tools to gain new insights into automotive system.
- ... create and optimize the behaviour of automotive systems based on system models

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. Basic Control

- Systematic System Modelling and Identification
- System Representation of SISO Systems (e.g. LDE, Transfer functions, Block diagrams)
- Simulation and Real-Time Simulation
- Stability Criteria and Frequency Response
- Continuous and Discrete PID-Controller Design

2. Advanced Control I

- Linear and non-linear State Space Representation
- State Space Controller Design
- Observer Design and Separation Theorem
- Digital Control / Discrete State Space Design
- LQR-Controller Design

3. Advanced Control II

- System Modelling using State Machines (FSM)
- Control Design with Fuzzy Control (FUZ)

4. Computer Lab

- 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 and Fuzzy Control applications
- MATLAB / SIMULINK / STATEFLOW Refresher Course

Modul ASM 3903 – Simulation and Control 1

5	**Participation Requirements** compulsory: Mathematics, Physics, Mechanics recommended: Control Engineering Basics, Basics in Matlab/Simulink
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination, 120 minutes
7	**Further Use of Module** Simulation and Control 2
8	**Module Manager and Full-Time Lecturer** Prof. Dr.-Ing. Gerd Wittler, Prof. Dr.-Ing. Walter Lindermeir
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** 16.4.2019

Modul ASM 3904 – Vehicle Technology

1	**Module Number** 3904	**Study Programme** ASM	**Semester** 1	**Offered in** XWS ☐SS	**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) Motor Vehicles		Lecture		3	45	105	Englisch
	b) Internal Combustion Engines		Lecture		3	45		
	c) Lab Motor Vehicles		Lab		1	15		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... explain the basic terms in vehicle technology and internal combustion engine technology
- ... describe the different vehicle concepts like front wheel, rear wheel and 4-wheel-drive
- … explain basic component parts of the chassis and the drive train
- … understand and calculate Rolling resistance, aerodynamic drag, climbing and acceleration resistance
- ... recognize the significance of the reduction of driving resistance for lowering fuel consumption and emissions
- … understand the relationship between power curve of combustion engines and the force and wheel speed at the driven wheels

Use, Application and Generation of Knowledge

Use and Transfer

- … choose the best engine and driveline combination for different types of vehicles.
- ... create testing reports and present test results.
- ... analyse the state of the art wheel suspension systems
- ... understand the physical behaviour of forces between road and tyre for vehicle dynamics simulation
- ... familiarize themselves with new ideas and topics in the field of automotive powertrains and suspensions

Scientific Innovation

- … find new technologies to lower fuel consumption and exhaust emissions of internal combustion engines.
- ... optimize powertrains for high driving performance
- ... set up new driving test procedures
- … calibrate tyre models to measurements
- ... independently develop approaches for new suspension and driveline concepts and assess their suitability.

Communication und Cooperation

- ... communicate actively within a research or development team and obtain information.
- ... interpret the results of vehicle testing and draw admissible conclusions.
- ... communicate with engine and chassis designers about new solutions

Scientific Self-Conception/ Professionalism

- … derive recommendations for decisions from an environmental and safety perspective on the basis of the analyses and evaluations made.
- ... justify the solution theoretically and methodically

Modul ASM 3904 – Vehicle Technology

4	**Contents** a) Lecture: **Motor Vehicles** The course gives a basic knowledge in vehicle technology and their components The power train is mainly focused The aim is to learn the ability to calculate driving resistance and to design the power train with respect to driving performance and fuel consumption b) Lecture: **Internal Combustion Engines** Internal Combustion Engine Fundamentals: Mechanics, Design, Kinematics, Thermodynamics, Gas Exchange, Mixture Preparation, Combustion, Emissions New Technologies, Developments and Trends of the Drive Train Advanced Knowledge in the fields of Engine Management, Turbo Charging and Direct Injection c) Lab: **Motor Vehicles** Determination of full-load torque and power pattern by using the car test bench Detection of fuel consumption map Determination of a tyre map by using the tyre test bench EUREPA. Analysis of vehicle road tests
5	**Participation Requirements** compulsory: no recommended: Fundamentals of Engineering Mechanics
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 Minutes
7	**Further Use of Module** 3906 Simulation and Control 2 3907 Team Project
8	**Module Manager and Full-Time Lecturer** Prof. Dr. K.L. Haken
9	**Literature** Heywood, J.B. Internal Combustion Engine Fundamentals McGraw-Hill BOSCH Automotive Handbook Distribution SAE
10	**Last Updated** 13.06.2019

Modul ASM 3905 – Electronics, Sensors and Measurement Techniques

1	**Module Number** 3905	**Study Program** ASM	**Semester** 1	**Offered in** ☒WS ☐SS	**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) Electronic Systems		Lecture		3	45	105	English
	b) Sensors and Measurement Technology		Lecture		3	45		
	c) Lab Actuators		Lab		1	15 [1 SWS = 15h]		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... understand basic functions of electronic systems.
- ... understand analogue and digital acquisition with sensors.
- ... evaluate interfaces for sensors.
- ... evaluate power stages for inductive loads.
- ... recognize the significance of electronics for automotive systems.
- ... apply microcontrollers for basic embedded systems.

Use, Application and Generation of Knowledge

Use and Transfer

- ... apply technical laws (e.g. Ohm / Kirchhof in OP-amp circuits).
- ... create technical reports and presentations.
- ... analyze technical solutions of EE-architectures for signal acquisition.
- ... recognize and classify connections.
- ... understand the basics of the signal acquisition, amplification and A/D-conversion.
- ... analyze technical problems and derive or develop solutions to integrate sensors in control circuits.
- ... design sensor acquisition concepts.
- ... familiarize themselves with new ideas and topics based on their basic knowledge by doing homework tasks.

Scientific Innovation

- … use methods and tools to gain new insights in the field (by working with Simulation models).
- ... create Simulation models for signal evaluation.
- ... optimize signal detection (e.g. speed detection with an incremental speed sensor).

Communication and Cooperation

- ... communicate actively within the lectures and obtain information.
- ... interpret the results of the field of sensor signal acquisition and treatment and draw admissible conclusions.
- ... 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 of homeworks theoretically and methodically.

Modul ASM 3905 – Electronics, Sensors and Measurement Techniques

4	**Contents** a) Lecture: Electronic Systems • terminology in electronic systems, • principal mode of operation, • block diagram, • ECU technology, • circuit design of interfaces, • bipolar transistors and MOSFET, • power stages for automotive applications, • hardware and basic programming of microcontrollers b) Lecture: Sensors and Measurement Technology • (Focus on automotive sensors for analogue and digital signal acquisition and transmission) • E/E-Architectures for signal acquisition (Sensor, A/D-conversion / signal conditioning) • Signal Theory (Bode-diagram and stability of amplifiers) • Resistive, capacitive and inductive based automotive sensors • Analogue signal acquisition with Operational Amplifier Circuits, basics, analysis of OA-Circuits , selected examples of basic circuits (inverting / non-inverting amplifier, instrumentation amplifier, integrator, low-pass, adder, comparator and Schmitt Trigger) • Digital signal acquisition, theory of digital to analog and analog to digital conversion, DAC principles, ADC circuits (Parallel, Successive Approximation (SAR), Pipelined ADC, Sigma-Delta ADC, voltage and charge integrating circuitries) • Examples of Automotive Sensor Circuits (Temperature, pressure, force, angular speed, etc.) • Replacing sensors by observers in the control unit (e.g. temperature modeling) c) Lab: Actuators Experiment: Investigations about three-phase asynchronous motor on system voltage and with frequency converter.
5	**Participation Requirements** **Compulsory:** • Fundamentals of Mathematics and Physics (electricity teaching) **Recommended:** part a) • Basics of programming language C part b) • Basics of programming with Matlab and modeling with Simulink • Fundamentals of electrical engineering including Ohm's law, Kirchhoff's laws, law of induction • Fundamentals of electronic components including capacitors, coils, diodes part c) • Basics of Electrical Engineering
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 Minutes, Lab Report
7	**Further Use of Module** Simulation an Control 2 Team Project
8	**Module Manager and Full-Time Lecturer** Dipl.-Ing. G. Mallebrein

Modul ASM 3905 – Electronics, Sensors and Measurement Techniques

9	**Literature** Bosch: Automotive Handbook 29th edition or newer - Karl-Heinz Dietsche and Konrad Reif Bosch: "Sensoren im Kraftfahrzeug" - Konrad Reif (only available in German) Tietze Schenk „Halbleiter-Schaltungstechnik" - Tietze, Schenk (only available in German) Infineon: C515C, 8-Bit CMOS Microcontroller Ronald Jurgen: Automotive Electronics Handbook, McGraw Hill For part b) Script from the lecturer: Chapter 0…6
10	**Last Updated** 16.06.2019 (by Georg Mallebrein)

Modul ASM 3906 – Simulation and Control 2

1	**Module Number** 3906	**Study Programme** ASM	**Semester** 2	**Offered in** WS XSS	**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) Longitudional Dynamics		Lecture		1	15	105	Englisch
	b) Ride Comfort Modeling and Simulation		Lecture		2	30		
	c) Automotive Controller Systems		Lecture		1	15		
	d) Lab Long. Dynamics,Ride Comfort and Autom. Contr. Systems		Lab		3	45		

Modul ASM 3906 – Simulation and Control 2

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... understand the modelling of longitudinal, lateral und vertical motion of vehicles
- ... describe the impact of suspension technology on ride comfort.
- ... calculate eigenfrequencies and eigenmodes of linear drivetrains.
- ... explain the basic types of automotive electric drives and their control and understand the connections within the powertrain domain.
- ... describe the working principle of electric drives and the actuation principle with a DC/AC converter.
- ... have basic knowledge in thermal modelling of powertrain components and in mechanisms to limit their power in order to protect the components from overheating.
- ... recognize the significance of drive-cycle simulation in optimizing electric powertrains.

Use, Application and Generation of Knowledge

Use and Transfer

- ... analyse different suspension technologies.
- ... understand the influence of drivetrains on fuel consumption of the engine.
- ... use state of the art simulation tools for vehicle dynamics.
- … apply a control strategy for a permanent magnet synchronous machine in a simulation environment.
- ... work with Simulink simulation models and interpret simulation results.
- … create energy flow diagrams of drive-cycle simulations of an electric vehicle and recognize the influence of vehicle parameters.
- … analyse the problem of component overheating and derive strategies to protect the components.
- … create technical reports and presentations in the domain of electric powertrains.

Scientific Innovation

- … use methods and tools to gain new insights in the field of vehicle dynamics.
- ... create new models for suspension and drivetrains.
- ... optimize conventional and hybrid drivetrains.
- … use simulation models and evaluation methods to gain the understanding of bi-directional energy flows in electric vehicles (propulsion / recuperation).
- … optimize the control strategy for a permanent magnet synchronous machine with the help of the theory of the field oriented control.
- … evaluate simulations and find general rules to minimize the energy consumption of electric vehicle.

Communication und Cooperation

- ... communicate actively within a development team with engineers from other disciplines.
- ... interpret the results of computer simulations and draw admissible conclusions.
- … present own simulation results to the class and interpret the results.
- ... cooperate in small working groups and create a common Laboratory report.
- ... use the learned knowledge, skills and competences to evaluate simulation results and interpret them.

Scientific Self-Conception/ Professionalism

- … derive recommendations for decisions from a social and ethical perspective on the basis of the analyses and evaluations made.
- ... justify their solutions and results theoretically and methodically in presentations.

Modul ASM 3906 – Simulation and Control 2

4	**Contents** a) Lecture: **Longitudional Dynamics** • simulation models for powertrains in Simulink • transient behaviour of flexible drive-trains • fuel- and energy consumption of hybrid and electrical cars b) Lecture: **Ride Comfort Modeling and Simulation** • advanced systems simulation techniques: operating point, linearization, frequency domain methods, dealing with nonlinearities, classical and advanced control • simulation models for vertical dynamics and ride comfort • suspension components: tire, damper, air spring, leaf spring, hydraulic actuator, etc. • road surface and terrain models • ride comfort assessment • active suspension: concepts, potentials, simulation **c)** Lecture: **Automotive Controller Systems** • Electrical Drives for automotive applications • Power Electronics for AC-Drives • Control Systems for AC-Drives (Field oriented control of a PMSM-Machine) • Electric Vehicle modelling and Drive-Cycle simulation • Thermal modelling of an Electrical Drive and Derating **d)** Lab: **Long. Dynamics, Ride Comfort and Autom. Contr. Systems** • Modeling and simulation of linear and nonlinear flexible drivetrain • Modeling and simulation of Toyota Prius Hybrid Drive • Modeling and simulation of the lecture topics (PMSM-control, Drive-Cycle-Simulation, Thermal simulation/derating) • Modeling and simulation of suspension systems
5	**Participation Requirements** compulsory: no recommended: undergraduate course in mechanics undergraduate course in electrical engineering undergraduate course in computer science, programming in C or C++ fundamentals of automotive engineering module ASM101 (Mathematical Methods in Engineering) module ASM103 (Simulation and Control 1)
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 Min, Lab reports
7	**Further Use of Module** Master Thesis
8	**Module Manager and Full-Time Lecturer** Prof. Dipl.-Ing. Mathias Oberhauser, Dipl.-Ing. Georg Mallebrein, Prof. Dr. Ralf Schuler

Modul ASM 3906 – Simulation and Control 2

9	**Literature** Wong: Theory of Ground Vehicles. SAE Oberhauser, M.: Lecture Notes Drive-Train Modeling and Simulation Schuler, R.: Lecture Notes Ride Comfort Modeling and Simulation Mallebrein,G: Lecture Notes Electric Drives Modeling and Simulation Matlab/Simulink Student Edition and on-line Documentation
10	**Last Updated** 30.06.2019

Modul ASM 3907 – Team project

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3907	ASM	2	WS X SS	1 Semester	compulsory	210	7

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	Team Project	Project work	3	45	165	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.
- ... consider 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

Modul ASM 3907 – Team project

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

Modul ASM 3908 – Automotive Communications

1	**Module Number** 3908	**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) Wireless and Wired Onboard and Offboard Communication Systems		Lecture		4	60	120	Englisch
	b) Automotive Man Machine Interactions (MMI)		Lecture		4	60		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... understand architecture, functionality and application of wired and wireless Onboard and Offboard communication systems.
- ... understand basic aspects of man machine interaction in automotive systems

Use, Application and Generation of Knowledge

Use and Transfer

- .. design and implement a MMI system
- ... setup a communication system in a vehicle

Scientific Innovation

- … use methods and tools to gain monitor bus systems
- ... independently develop approaches for new MMI concepts and assess their suitability.

Communication und Cooperation

- ... communicate actively within an organization and obtain information.
- ... present technical contents and discuss them.
- ... communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- … derive recommendations for decisions from a social and ethical perspective on the basis of the analyses and evaluations made.

Modul ASM 3908 – Automotive Communications

4	**Contents** Lecture a): **Wireless and wired Onboard and Offboard communication systems:** Protocol architectures of communications systems • OSI/RM • TCP/IP Wireless Onboard Communication Systems • Bluetooth • RFID • ZigBee Wired Onboard Communication Systems (vehicle busses) • Multimedia bus (MOST) Lecture b): **Man Machine Interaction** • Basics Terms, historical view on man machine dialogue, requirements of graphical user interfaces, design requirements (software ergonomics, usability, dialog principles). On-board Pattern Recognition Systems. • machine vision systems (e.g. in traffic monitoring and automatic congestion detection, in driver assistance systems, for gesture recognition) • speech communication: speech recognition and understanding systems, speech dialogs: speech synthesis and language generation (Human-Machine Interface). • usability engineering, testing and evaluation of recognition systems Driver Assistance Systems • concepts for programming of driver assistance systems in automobiles: environment models, interpretation and fusion of sensor data, piloting functions, cooperative concepts. • implementation of important concepts in laboratory – user-centered design Human Factors Engineering • human factors, such as vision, cognition • driver attention and distraction • usability, user-centered design • multimodal Interfaces Lab (programming exercises and presentations, simulation) Project • selected tasks with overall semester project (group work)
	Participation Requirements compulsory: - recommended: Lecture a): • Basics in communication systems and computer networks, • Programming in C/C++/Java Lecture b): • Knowledge of a programming language, preferable C/C++/Java Programming in C/C++/Java
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 120 min
7	**Further Use of Module** Master Thesis

Modul ASM 3908 – Automotive Communications

8	**Module Manager and Full-Time Lecturer** Prof. A. Beck, Prof. Dr. M. Zieher, Prof. Dr. H. Melcher
9	**Literature** Lecture a): • Selected journal publications, • Lecture documents, • Gremba, Andreas (Editor): "MOST - the automotive multimedia network",Franzis Verlag, 2008, ISBN 978-3-7723-5316-1, also available as free ebook. Lecture b): • Karl-Friedrich Kraiss, Advanced Man-Machine Interaction . Fundamentals and Implementation (Signals and Communication Technology) Springer 2006
10	**Last Updated** 04.07.2019

Modul ASM 3909 Reliable Embedded Systems

1	**Module Number** 3909	**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) Safety and Security		Lecture		4	60	120	Englisch
	b) Selected Topics on Real-Time Systems		Lecture		4	60		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... analyze, design, and implement safety-critical distributed real-time systems
- ... understand safety and security issues in the development of automotive applications

Use, Application and Generation of Knowledge

Use and Transfer

- … understand the requirements for distributed real-time systems
- ... understand and apply the concept of global time
- ... understand the concept of fault, errors, and failures
- ... understand event-triggered and time-triggered real-time communication
- ... understand real-time operating systems and real-time scheduling
- ... understand how to validate distributed real-time systems
- ... understand the main concepts: safety, functional safety, security, information security.
- … understand the main concepts in security
- ... be aware of security threats in the automotive domain
- ... understand security risk management
- …understand safety and security in vehicular ad hoc networks (VANETs)
- …understand the main concepts in safety
- …understand safety management according to ISO 26262

Scientific Innovation

- … use methods and tools to gain new insights in the field of reliable embedded systems

Communication und Cooperation

- ... use the learned knowledge, skills and competences to evaluate communication systems 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

- … derive recommendations for decisions from a social and ethical perspective on the basis of the analyses and evaluations made.
-

Modul ASM 3909 Reliable Embedded Systems

4	**Contents**
	Lecture a): **Safety and Security**
	• Main concepts: safety, functional safety, security, information security
	• Main concepts in security
	• Security threats in the automotive domain, e.g.
	  ○ Insecure bus systems
	  ○ Chip manipulation
	  ○ Component theft
	  ○ Evading access controls
	• Counter measures based on cryptography
	• Security risk management
	• Safety and Security in vehicular ad hoc networks (VANETs)
	• Main concepts in safety
	• Safety management according to ISO 26262
	
	Lecture b): **Selected Topics on Real-Time Systems**
	• Basic concepts for real-time systems
	• Distributed architectures and global time
	• Modeling real-time systems
	• Fault tolerance
	• Real-time communication
	• Real-time operating systems
	• Real-time scheduling
	• Validation of real-time systems

	Participation Requirements compulsory: - recommended: • C/C++ programming • computer architecture basics • operating system basics • object oriented modelling (UML)
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. D. Schoop, Prof. Dr. A. Friedrich
9	**Literature** • *Kopetz, H.: Real-Time Systems, Kluwer 1997* • *Veríssimo, P. and Rodrigues, L.: Distributed Systems for System Architects, Kluwer 2001* • *Lecture material*
10	**Last Updated** 04.07.2019

Modul ASM 3910 – 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		

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**

a) 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 description of the tire, nonlinear model, yaw velocity damping characteristics, effects of design parameters and the road/tire friction coefficient on handling performance

b) Lecture Suspension Modeling

terminology in multibody dynamics, kinematics of free bodies, force and torque elements, play and friction, Newton-Euler equations, constraint functions, 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 suspensions 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 3903 Simulation and Control 1

Modul ASM 3910 – Ride and Handling

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

Modul ASM 3911 – Powertrain

1	**Module Number** 3911	**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) Transmission Systems		Lecture		3	45	120	Englisch
	b) Transmission Control		Lecture		3	45		
	c) Engine Control Systems		Lecture		2	30		

3 **Learning Outcomes and Competences**

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

Knowledge and Understanding

- ... explain the basic procedure of transmission control
- ... explain the basic procedure of combustion engine control
- … describe the design of state-of-the art transmissions like planetary gear sets, double clutch and continuously variable transmissions.
- ... recognize the significance of transmission control on fuel consumption and performance

Use, Application and Generation of Knowledge

Use and Transfer

- … analyze power train systems regarding speeds, torques and efficiency.
- ... calculate results of transient engine operation with the help of simulations.
- ... familiarize themselves with new ideas about engine control functions based on their basic knowledge of engine control
- ... analyse technical problems (e.g. caused by tolerances of components) and derive or develop solutions (adaptive engine control functions).

Scientific Innovation

- … use methods and tools to gain new insights in the field of combustion engines with the help of simulation models.
- ... create new models and control functions in the field of combustion engines + their control.
- ... optimize system behaviour by calibration of parameters

Communication und Cooperation

- ... work together with electronic and software experts in the field of electronic control units
- ... discuss new solutions for powertrains with design engineers
- ... present technical contents in the field of powertrain technology and discuss them.
- ... communicate and cooperate within the group in order to find adequate solutions for the task at hand.

Scientific Self-Conception/ Professionalism

- … derive recommendations for decisions from an environmental perspective on the basis of simulations and calculations made.
- ... justify solutions theoretically and methodically by presenting their simulation homework in front of the class

Modul ASM 3911 – Powertrain

4	**Contents** a) Lecture **Transmission Systems** • Calculation of vehicle performance data, Demands for vehicle transmissions Range of transmissions • Planetary gear sets, Speed sheet, Torque calculation • Continuously variable torque converters Mechanical variable torque converters Hydrodynamic torque converters • Automatic transmissions Shifting components • Power split transmission • Hybrid transmission, parallel systems, serial systems b) Lecture **Transmission Control** • Electro hydraulic transmission control systems. • Mathematical models for pressure control valves and shift process. • Shift schedules for optimal fuel economy and best drive ability. • Electronic control units for transmission control including interfaces and power stages. • Driving strategy using car to car and car to infrastructure communications. **c)** Lecture **Engine Control** • Basic knowledge of the Otto combustion engine and the needed components to control the engine • History and new trends of gasoline engines • ECU functions for torque structure, load detection, injection time calculation and ignition timing including the control functions “idle speed control” and “Lambda control” • Matlab / Simulink simulation model of the Otto engine and the engine control unit • Perform simulations with parameter variation with the help of the model • Outlook for future power train concepts like hybrid vehicles / electric vehicles
5	**Participation Requirements** compulsory: no recommended: undergraduate course in mechanics (especially planar kinematics and kinetics) undergraduate course in hydraulics and control
6	**Examination Forms and Prerequisites for Awarding ECTS Points** Written Examination 150 Minutes
7	**Further Use of Module** Master Thesis
8	**Module Manager and Full-Time Lecturer** Prof. Dipl.-Ing. Werner Klement
9	**Literature** BOSCH: Automotive Handbook, Distribution SAE Klement, W.: Fahrzeuggetriebe Hanser Verlag Lechner, G. ; Naunheimer, H.:Automotive Transmissions Springer Verlag

Modul ASM 3911 – Powertrain

10	**Last Updated** 15.06.2019

Modul ASM 3912 – Electric and Electronic Architecture

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3912	ASM	2	SS	1 Semester	compulsory	270	9

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Electronics and Communication 1	Lecture	3 (2)	45	135	Englisch
	b) Prototyping and Simulation	Lecture	1 (2)	15		
	c) Optical Systems	Lecture	4	60		
	d) Lab Optical Systems	Lab	1	15		

3 Learning Outcomes and Competences

Once the module has been successfully completed, the students can describe and explain ...

- the coding and bus access of various automotive communication protocols
- the HW-architecture, design, prototyping and simulation of ECUs under automotive boundary conditions
- the principles of basics photometry and basics ray optic
- automotive lighting (application, interfaces, LEDs) and cameras (night vision, optical driver assistance)

Furthermore they understand and are able to run ...

- experimental characterizing of optical components representing examples of automotive applications

4 Contents

a) Lecture:
- Communication basics (e.g. coding and bus-access)
- Requirements to automotive communication (latency, protocols, communication matrix etc.)
- Protocols (e.g. CAN, CAN-FD, LIN, FlexRay, automotive Ethernet)
- Standardizations (e.g. OSEK, Autosar)
- Hardware architecture of non-permanently or permanently powered electronic control units (e.g. prototypes, placement, layout, topologies)
- Design of automotive electronics modules (e.g. reverse connection protection, analogue and digital signal acquisition, linear and switching regulators) basics to ensure EMC automotive requirements to ECUs (e.g. temperature, vibrations, power supply (e.g. jump-start, load dump))
- Electrical and behaviour simulation of electronics automotive components (e.g. by CANoe, SPICE, Matlab etc.)
- Simulation of dedicated automotive circuits photometry und ray optics, lighting and cameras
- Implementation, test and start-up of typical automotive applications

b) Tutorial: -

c) Lab:
Experimental characterizing of optical components representing examples of automotive applications.

5 Participation Requirements

compulsory: Advanced theoretical and practical knowledge in electronics (analogue and digital) and software technologies (language C) as well as serial communication.

recommended: Bachelor of Engineering in Electronics, Mechatronics or similar

6 Examination Forms and Prerequisites for Awarding ECTS Points

Written examination, 150 minutes

7 Further Use of Module

none

8 Module Manager and Full-Time Lecturer

Prof. Jürgen Minuth, Prof. Alexander Hornberg

9 Literature

Handouts

10 Last Updated

18th of June 2019

Modul ASM 3913 – Packaging and Integration

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3913	ASM	2	SS	1 Semester	compulsory	210	7

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Packaging and Wire Harness	Lecture	2	30	105	Englisch
	b) Automotive EMC	Lecture	1	15		
	c) Electronics and Communication 2	Lecture	2	30		
	d) Lab Car Electronics	Lab	2	30		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can describe and explain...

- ECU topologies, the electro-magnetic behaviour of cables, signal shapes in the time domain
- Sources of interferences, measurement procedures, design rules.
- Protocol circuits, physical layer components, electrical requirements to ECUs, distributed communication, signal levels, modelling of ECU's behaviour.

Furthermore they understand and are able to run ...

- the design, test and start-up of electronic systems for automotive applications.

4 **Contents**

a) Lecture:
- Protocol circuits and transceiver (e.g. CAN, CAN-FD, LIN, FlexRay, automotive Ethernet)
- ECU technologies
- electro-magnetic behaviour of cables
- Standardized SW-modules (e.g. network management, communication and operating system)
- Aspects of EMC when using e.g. switched inductive loads, valves, stepper motors, busses
- Aspects of EMC sceneries e.g. ground bounce (statically and dynamically), common mode and differential mode, X-talk, radiation and irradiation, Faraday cage approaches to handle EMC e.g. common mode coils, ferrites, capacitors, layout, ground connections, arrangement of the wiring, shielding, specifications and interfaces, cables and wiring harness, cable channel, splices, available, lead through, cut point (connectors)
- Technologies of ECUs e.g. standard design with printed circuit boards and surface mounted devices up to thick film integration modules with bond-out chips gateways
- Levels of abstraction e.g. applications, functions, tasks, signals, PDUs; ECUs, messages simulations e.g. rest-bus, transmissions lines, electromagnetic fields

b) Tutorial: -

c) Lab:
The content depends on the specified requirements for the module 3907 named team project; examples are introductions into CANoe, LT-Spice or Altium designer

5 **Participation Requirements**

compulsory: Advanced theoretical and practical knowledge in electronics (analogue and digital) and software technologies (language C) as well as serial communication.

recommended: Bachelor of Engineering in Electronics, Mechatronics or similar

6 **Examination Forms and Prerequisites for Awarding ECTS Points**

Written examination, 150 minutes

7 **Further Use of Module**

none

8 **Module Manager and Full-Time Lecturer**

Prof. Jürgen Minuth, Prof. Gerd Wittler

9 **Literature**

Handouts

10 **Last Updated**

18th of June 2019

Modul ASM 3914– Softskills

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	3914	ASM	1	WS	1 Semester	compulsory	210	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		

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 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.

Modul ASM 3914– Softskills

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** **a) and b) (Global Engineering & Project Management)** • 90 min written exam • Presentation in a group , 20 minutes **c) International Negotiations** • 60 min written exam (based on attending class and role plays)
7	**Further Use of Module** Module Team Project, Preparation for Master thesis, Preparation for negotiations in job sitatuions
8	**Module Manager and Full-Time Lecturer** Prof. Dr. Siegfried Zürn - plus external experts and lecturers

Modul ASM 3914– Softskills

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** 2019-06-18

Modul ASM 3915 – 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		Thesis		2	30	600	Englisch
	Master Thesis Presentation and Defence		Presentation		1	15	45	

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 oral examination , 30 minutes

Thesis report

7 **Further Use of Module**

Preparation for Master thesis

Modul ASM 3915 – Master Thesis

8	**Module Manager and Full-Time Lecturer** Prof. Mathias Oberhauser
9	**Literature**
10	**Last Updated** 23.04.2019