HOCHSCHULE ANHALT University of Applied Sciences

Module Manual

for the Master Degree Program

Electrical and Computer Engineering

April 2023

		Focus		
Module ID	Module	Automation	Embedded Systems	Communication systems
MET_01_01_M	Software Design	PM	PM	PM
MET_01_02_M	Development of Electronic Systems	PM	PM	PM
MET_01_03_M	Project Work	PM	PM	PM
MET_01_04_MA	Control Systems	PM		
MET_01_04_MEK	Operating Systems		PM	PM
MET_02_01_M	Hardware / Software Co-Design	PM	PM	PM
MET_02_02_M	Statistical Methods	PM	PM	PM
MET_02_04_MA	Autonomous Systems	PM		
MET_02_04_MEK	Real Time Systems		PM	PM
MET_02_05_MK	Channel Coding			PM
MET_02_06_MK	Mobile Communications			PM
MET_E1_AEK	Virtual, Mixed and Augmented Reality	WPM	WPM	WPM
MET_E2_AEK	Machine Learning and AI	WPM	WPM	WPM
MET_E3_AEK	Internet Security	WPM	WPM	WPM
MET_E4_K	Advanced Network Administration			WPM
MET_E5_AEK	Interdisciplinary Project	WPM	WPM	WPM
MET_E6_A	Mechatronics	WPM		
MET_E7_AE	Sensor and Actuator Technology	WPM	WPM	
MET_E8_AEK	Systems Programming	WPM	WPM	WPM
MET_E9_AEK	Optoelectronics	WPM	WPM	WPM
MET_E10_AEK	German language	WPM	WPM	WPM
MET_E11_AEK	Engineering Ethics	WPM	WPM	WPM
MET_E12_AEK	Quality Assurance Expert	WPM	WPM	WPM
MET_E13_AEK	Project Management and Quality Assurance	WPM	WPM	WPM
MET_E14_AEK	Business Start Up	WPM	WPM	WPM
MET_03_01_M	Master Thesis	PM	PM	PM

PM : Compulsory Module
WPM: Elective Module

Module	Software Design						
General data							
ID	MET_01_01_M						
Study programs	MET			**Regular semester**	Summer term		
Module Frequency	Annual			**Duration**	1 semester		
Assignment to the curriculum	Compulsory Module (all focal points)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	**Prof. Dr. Ingo Chmielewski**						
Teaching Staff	**Prof. Dr. Ingo Chmielewski, MA. Eng. Tobias Müller**						
Requirements	**No formal prerequisites; professional prerequisites:** Knowledge of programming with procedural programming languages						
Class	**Lecture**		**Exercise/Seminar**	3 hours per week per semester (2.25 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	125 hours in total, of which 50 in presence and 75 self-study						
Contents	Introduction object orientation: Advantages ↔ disadvantages on practical example • Structure of the model-based software design from analysis to design • Visual modeling with UML • UML interaction diagrams as a communication tool in software design • From UML diagram to program code • Test strategies of software systems • Practical training with the PC/laptop						
Course Objectives and Targeted Competencies	Students have become familiar with the content and structure of model-based software development and know how to apply the principles of the various models to the analysis, design, implementation, testing, and subsequent maintenance of software systems. In particular, object-oriented problem analysis and the design of a solution path are explained to the students by means of practical case studies. The programs to be created are written using the Python or C++ programming language.						
	Interdisciplinary Competencies: Model-based software design considering test strategies						
Hardware and Software used	PC/laptop, GNU based development environment						

Literature and Sources	• Larman, C., UML 2 and Pattern applied - object-oriented software development, mitp-Verlag, Frechen, 2005 • Gamma, E. ; Helm, R. ; Johnson, R. ; Vlissides, J.: Design Patterns: Entwurfsmuster als Elemente wiederverwendbarer objektorientierter So\ware. 1.Aufl. mitp-Verlag, 2015 • Vijayakumaran, S. Versionsverwaltung mit Git, mitp-verlag, Frechen, 2016

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	**Mandatory Examination Prerequisites:** Paper; **Type of examination:** Written exam (120 min.) or term paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Written exam 100 % or term paper 100%
Notes	Taught in English		

Module	Development of Electronic Systems						
General Data							
ID	MET_01_02_M						
Study programs	MET			**Regular semester**	Summer term		
Module Frequency	Annual			**Duration**	1 semester		
Assignment to the curriculum	Compulsory Module (all focal points)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Dr. Michael Brutscheck						
Teaching Staff	Prof. Dr. Michael Brutscheck; Graduate Engineer Harald Prütting						
Requirements	**No formal prerequisites;; Professional Prerequisites:** Knowledge of electronic circuits, materials, components, technologies.						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	- Introduction - Process of product development of electronic systems (- Areas of responsibility of the Marketing and Development divisions) - Development steps Specification, concept, circuit input, circuit implementation - Verification in product development						
Course Objectives and Targeted Competencies	**Professional Competencies:** Students have an overview of the product development process for electronic systems and are familiar with the various development steps. Students acquire an in-depth understanding of systems engineering and product development methodology, in particular knowledge of the topics of product development (organization, quality, costs, sustainability). **Interdisciplinary Competencies:** Students are enabled to apply the competencies acquired in the bachelor's program on electronic circuits, materials, components and technologies in a comprehensive design process. They learn to compare different solution options in terms of multi-criteria optimization, also with regard to non-technological requirements. They deepen the social skills they have acquired through intensive group work.						
Hardware and Software used	SW: Circuit simulation (e.g. Multisim), HW: Circuit design on the plug-in board; slides, blackboard, scripts, exercises, worksheets						
Literature and Sources	- Winzker, M.: Elektronik für Entscheider, Springer Vieweg Verlag - Tietze / Schenk: Halbleiterschaltungstechnik. Springer Verlag						

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts, Practical papers; Type of examination: Draft/Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Design / Paper: 100 percent
Notes	**Taught in English**		

Module	Project Work						
General Data							
ID	MET_01_03_M						
Study programs	MET			**Regular semester**	Winter term		
Module Frequency	Annual			**Duration**	1 semester		
Assignment to the curriculum	Compulsory Module (all focal points)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Dr. Marc Enzmann						
Teaching Staff	Lecturers of the department						
Requirements	**No formal requirements;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	0 hours per week per semester	**Practical training**	0 hours per week per semester	
Workload	125 hours in total, thereof 125 self-study hours						
Contents	By arrangement: Students demonstrate the ability to independently analyze a scientific/technical issue, develop a solution, and elaborate the solution. You will discuss your results with the supervising university professor and discuss advantages and disadvantages of different approaches.						

Course Objectives and Targeted Competencies	**Interdisciplinary Competencies:** Students can - independently, alone or in small groups, present, structure, and evaluate a scientific or technical topic in writing and orally in a limited amount of time, - Name and apply rules of care in the preparation of scientific papers and/or presentations, - Plan and independently perform work steps in the creation of scientific or technical work, - Conduct literature research independently, critically evaluate literature sources and apply citation methods (also in presentations), - Use software to create project work and presentations (including literature management programs, if applicable), - Implement techniques of good scientific presentations, - Design group work in a goal-oriented manner, - Apply feedback rules and reflect their own way of working.
Hardware and Software used	
Literature and Sources	

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Type of Examination: Draft/Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Design / Paper: 100 percent
Notes	**Taught in English**		

Module	Control Systems						
General Data							
ID	MET_01_04_MA						
Study programs	MET		**Regular semester**	Summer term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory Module (all focal points)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr.-Ing. Marc Enzmann						
Teaching Staff	Prof. Dr.-Ing. Marc Enzmann; Graduate Engineer Roberto Wolff						
Requirements	**No formal prerequisites; professional prerequisites:** Completed module "Control Engineering" from the Bachelor's degree with at least 5 ECTS or comparable.						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	4 hours per week per semester	**Practical training**	2 hours per week per semester	
Workload	Workload 125 hours, of which 60 in presence and 65 self-study						
Contents	**Fixed content:** Multivariable control in state space (state recirculation, observer-based design, pole placement, optimal design, multivariable I controllers and PI controllers); digital implementation of controllers; **Flexible content:** Advanced procedures for controller design, in consultation with students: a.) nonlinear control methods: Gain-scheduling, full linearization b.) Design of predictive controllers c.) Design of robust single- and multivariable controllers in the frequency domain with Quantitative Feedback Theory						

Course Objectives and Targeted Competencies	**Professional Competencies:** **Fixed content:** Students will be able to derive the state space representation from each of several basic models. They are able to analyze analytically and numerically the properties of the state space models, they have a deeper understanding of the properties. Students know the canonical forms and can convert state models analytically and numerically into the canonical forms. Participants of the class will be able to design complete state recirculation systems using various methods. They have an in-depth understanding of observer structures and can design both Luenberger observers and Kalman filters for a given problem and integrate them into a control loop. The participants know and understand the extensions of the state controllers by I or PI components and can dimension I controllers or PI controllers for a given problem with the learned methods of pole placement or controller optimization. **Flexible content:** the participants acquire basic knowledge of advanced control methods in the variable part of the course. They investigate the underlying motivation, and the mathematical-algorithmic foundations of the procedures, evaluate the strengths and weaknesses of the procedures, and test the procedures simulatively. **Interdisciplinary Competencies:** Critical comparison of different procedures, simulative and program implementation; teamwork; strengthening the ability to acquire knowledge independently.
Hardware and Software used	Simulation tool Matlab / Simulink or SciCos / Cos
Literature and Sources	Blackboard, presentations, simulations Dorf / Bishop: Moderne Regelungssysteme (Pearson-Verlag) Adamy: Nichtlineare Systeme und Regelungen (Springer / Vieweg) Camacho / Bordons: Model Predictive Control (Springer Verlag) Diverse Paper zur Quantitative Feedback Theory

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Written drafts on subfields; Type of examination: Term paper and presentation		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Term Paper 80%; Presentation: 20 %
Notes	**Taught in English**		

Operating Systems Module							
General Data							
ID	MET_01_04_PEK						
Study programs	MET			**Regular semester**	Summer term		
Module Frequency	Annual			**Duration**	1 semester		
Assignment to the curriculum	compulsory module (Embedded Systems, Communication Systems)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Siemens						
Teaching Staff	Prof. Siemens						
Requirements	**No formal prerequisites**; **professional prerequisites**: Knowledge, programming, computer networks, communication systems						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						

Contents	• Definition of operating systems
	• Historical development of operating systems
	• Operating system design - microkernel, monolithic kernel, hybrid kernel
	• Operating system subsystems
	  • Memory management
	  • Processes and scheduling
	  • Files and file systems- Files and file systems
	  • User management
	  • Inter-Process Communications
	• Structure of the Linux operating system and its use by means of BASH in the practical training						

Course Objectives and Targeted Competencies	**Professional Competencies:** Students have knowledge of the essential concepts and tasks of modern operating systems and the associated software components. They are familiar with the various structural approaches and the associated challenges of programmatic implementation and use. They will be able to start a Linux system, administer it, read out the important performance parameters, evaluate and optimize it. They are able to set up and administer a user administration. **Interdisciplinary Competencies**: students will be able to classify the competencies acquired in the basic studies for the development of software in the context of the execution by the operating system. You will learn to compare different OS architectures, and select them for different use cases.
Hardware and Software used	PC systems with Linux, virtual machines with root acces to the Linux system, an Ethernet/IP network
Literature and Sources	Präsentationsfolien, Vorlesungsskripte, Online-Material. A. S. Tanenbaum „Moderne Betriebssysteme“, Pearson 3., aktualisierte Auflage, 2009 ISBN 978-3-8273-7342-7 Available in the university library A. S. Tanenbaum „Computerarchitektur. Strukturen – Konzepte – Grundlagen“, Pearson 5. Auflage, 2006

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Laboratory practical training; Type of examination: Draft/Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Draft/ Paper 100 %
Notes	**Taught in English**		

Module	Hardware / Software Co-Design						
General Data							
ID	MET_02_01_M						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory Module (all focal points)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Brutscheck						
Teaching Staff	Prof. Dr. Brutscheck, Prof. Dr. Chmielewski						
Requirements	**No formal prerequisites**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	Programmable logic elements - Low Cost FPGA series e.g. Cyclone (Intel) - Basics of the programming language VHDL - System On Programmable Chip (SOPC) - Practical training (e.g. MP3 streaming via Ethernet with Intel FPGA Cyclone IV)						

Course Objectives and Targeted Competencies	**Professional competencies:** Students have an overview of the design, differences and use of simple programmable logics up to complex FPGA (Field Programmable Gate Array). They know the evaluation board to be used from e.g. Intel in the basic features of the design, the configuration as well as the interfaces. The "Tool Chain" has been discussed and an introduction to the Quartus development environment has been given. The students have learned all the essential structural elements of VHDL (Very High Speed Integrated Circuit Hardware Description Language) in the form of a compact tutorial and are able to formulate simple algorithmic problems in VHDL. They have understood the basic principle of a software CPU and are able to configure it as well as to implement simple problems both in VHDL as a hardware solution and in software using the software CPU (Nios II) and the C programming language. Based on the contents and experiences, the students can implement, for example, an MP3 player that receives its data as an IP stream from a "remote computer". **Interdisciplinary Competencies:**
Hardware and Software used	e.g. Intel FPGA development board and associated IDE
Literature and Sources	- Gessler, Mahr: Hardware-So\ware-Codesign. Vieweg Verlag - Hwang: Digital Logic and Microprocessor Design with VHDL. Thomson Verlag - Chu: Embedded SoPC Design with Nios II Processor and VHDL Examples. Wiley Verlag

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts and programming assignments; Type of examination: Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Paper 100 %
Notes	**Taught in English**		

Module	Statistical Methods						
General Data							
ID	MET_02_02_P						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory Module (all focal points)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Dietrich Romberg						
Teaching Staff	Prof. Dr. Dietrich Romberg; Graduate Engineer Ulf Heinisch						
Requirements	No formal prerequisites; professional prerequisites: Signals and Systems, Digital Signal Processing						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	• Discrete-time stochastic signals • Random variables, random processes • Transformation of random processes by systems • Representation of transient processes • Parameter estimation • Signal and pattern recognition • Time series analysis • Wiener - filter, Kalman filter						
Course Objectives and Targeted Competencies	**Professional competencies:** Students are able to use methods to describe and model statistical signals and processes and to differentiate them from corresponding methods for deterministic signals. Based on basic knowledge of methods of parameter estimation and interference signal suppression for stationary signals and systems, students are able to independently design and implement efficient algorithms for the analysis and processing of these signals in the Matlab / Simulink programming environment. Furthermore, students will be able to describe and compare different approaches for suppressing interfering signals. The acquired knowledge and skills are to be applied within the framework of a paper, and different approaches to solutions are to be discussed and evaluated. **Interdisciplinary Competencies:**						
Hardware and Software used							

Literature and Sources	Kroschel, Rigoll, Schuller: Statistische Informationstechnik, Signal- und Mustererkennung, Parameter- und Signalschätzung; Springer-Verlag Händler: Statistische Signale; Springer-Verlag Köhler: Konzepte der statistischen Signalverarbeitung; Springer-Verlag

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts, programs; Type of examination: Oral examination		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Oral Exam: 100 %
Notes	**Taught in English**		

Module	Autonomuous Systems						
General Data							
ID	MET_02_04_MA						
Study programs	MET			**Regular semester**	Winter term		
Module Frequency	Annual			**Duration**	1 semester		
Assignment to the curriculum	Compulsory module (Automation); Elective module (Embedded Sys.)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Dr.-Ing. Stefan Twieg						
Teaching Staff	Prof. Dr.-Ing. Stefan Twieg; Patrick Nulsch						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	• Introduction to autonomous systems and robotics • Machine Learning Basics (Supervised and Unsupervised Learning) • Problem definition, derivation of the relevant questions • Actuators and sensors (classification and characteristics) • Machine-to-machine communication (e.g. MQTT) • Model architecture as well as methods for the implementation on embedded systems • Validation methods • Programming exercises and design of an autonomous system						

Course Objectives and Targeted Competencies	**Professional Competencies:** Students have knowledge of the design and operation of mechatronic systems as well as the methods of machine learning and can apply them in the field of autonomous systems and robotics. They gain the ability to develop autonomous systems. They understand the required mathematical and physical description forms of simple mechatronic systems. They can analyze given problems of autonomous systems and develop and implement algorithms to solve them. Students gain detailed knowledge and the ability to implement and document the software on embedded systems (e.g. based on a RaspberryPi). **Interdisciplinary Competencies:** Group work in the practical part challenges and promotes the students' ability to work in a team and their social skills.
Hardware and Software used	Computers, Office, Meters, Experiments, Raspberry Pi, Linux, Python
Literature and Sources	Slides, blackboard, scripts, PC • Hunt, John: A Beginners Guide to Python 3 Programming, Springer Verlag • Hunt, John: Advanced Guide to Python 3 Programming, Springer Verlag • Follmann, Rüdiger: Das Raspberry Pi Kompendium, Springer Verlag • Bishop, C. M.: Pattern Recognition and Machine Learning. Springer Verlag • K. D. Kammeyer and K. Kroschel: Digitale Signalverarbeitung. Teubner Verlag • Hagmann: Grundlagen der Elektrotechnik. AULA Verlag • Andrew S. Tanenbaum. Computer Networks. Pearson Studium, fourth edition, 2003 • Behrouz A. Forouzan. TCP/IP Protocol Suite. McGraw-Hill, second edition,2003 • MacKay, David J.C.: Information Theory, Inference and Learning Algorithms. Cambridge Uni. Press • Kruse, R. (et al.): Computational Intelligence, Eine methodische Einführung in Künstliche Neuronale Netze, Evolutionäre Algorithmen, Fuzzy- Systeme und Bayes-Netze. Springer Verlag

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: passed practical training; Type of examination: Draft/Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Draft/ Paper 100 %
Notes	**Taught in English**		

Module	Real-Time Systems						
General Data							
ID	MET_02_04_MEK						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory module (Embedded Systems, Communication Technology)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Ingo Chmielewski						
Teaching Staff	Prof. Dr. Ingo Chmielewski						
Requirements	No formal prerequisites; professional prerequisites: Programming knowledge in C						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	3 hours per week per semester (2.25 h)	**Practical training**	1 hours per week per semester (0.75 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	Introduction: Definitions, requirements and basic models for real-time systems Design principles: Processes, scheduling of concurrency, allocation of system resources, ensuring real-time requirements Synchronization and communication of processes Real-time operating system using RT-Linux as an example: System concept, task model, I/O structure, process generation, system objects, memory management Practice project: Planning and programming of test processes under RT-Linux						
Course Objectives and Targeted Competencies	**Professional Competencies:** the participants understand the specifics of and requirements for operating systems in the context of real-time operation. They will be able to map time requirements for software processes to system structures. They will acquire detailed knowledge of the effect of mechanisms for inter-process communication and time management of system resources. Students possess the competence to plan and program complex multiprocess applications. **Interdisciplinary Competencies:** Students will be able to identify and describe hard and soft real-time requirements in practical applications, and identify and develop the implementation of a solution. You can compare different implementation forms (threading models) and select suitable ones for the given application. The participants' ability to acquire knowledge independently and to work in groups is strengthened.						

Hardware and Software used	BeagleBone, RaspberryPi, RT Linux, Zephyr port to ARM-based Arduino platform
Literature and Sources	• Zöbel: Real-time systems. Basics and techniques. Internat. Thomson Publishing • Cheng: Real-Time Systems. Scheduling, Analysis and Verification; Wiley Interscience • Raghavan: Embedded Linux System Design and Development; Auerbach Publications • Burns, Wellings: Real-Time Systems and Programming Languages • J. W. S. Liu: Real-Time Systems, Upper Saddle River 2000, Prentice Hall

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts; program text; Type of examination: Written exam (120 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Written exam 100 %
Notes	**Taught in English**		

Module	Channel Coding						
General Data							
ID	MET_02_05_MK						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory module (communication technology)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof Siemens						
Teaching Staff	Prof. Siemens, Dr. Vasylenko						
Requirements	**No formal prerequisites**; **Professional Prerequisites**: Communication Systems, Computer Networks, Measurement Technology modules or equivalent.						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester	**Practical training**	2 hours per week per semester	
Workload	Workload 125 hours, of which 60 in presence and 65 self-study						
Contents	* Basics of Codes and Channels • Information Theory of Shannon • Block codes • Linear Block Codes • Cyclic Block Codes • Viterbi Algorithm and Trellis Codes • Interleaving and Reed-Solomon codes • Example of coding technologies in actual applications like CD, GSM and DVB • ARQ Codes, Go-back-N • Performance of G-back-N • Practical implementation of an ARQ-based reliable data transport in the programming language Python • Windows ws. Rate-based connection control						

Course Objectives and Targeted Competencies	**Professional Competencies:** The students have knowledge of mathematical models of information transmission systems. They will be able to assess the power of deployed codes in terms of error-protection and performance, and you will be able to develop new codes. Students will be able to implement a transmission system with error correction in the Python programming language. **Interdisciplinary Competencies:** The students are able to analyze a complex software task in a group, to divide it into subtasks and to coordinate the processing in the group.
Hardware and Software used	Computer running Linux, an Etehrnet-based transmission system with a network impairment emulator, a Pyhton programming environment
Literature and Sources	Slides, balckboard, scripts as PDF documents, video material Literature: TBD:

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Passed practical training, draft (software task); Type of examination oral examination (20 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Oral exam 100 %
Notes	**Taught in English**		

Module	Mobile Communications						
General Data							
ID	MET_02_05_MK						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	Annual		**Duration**	1 semester			
Assignment to the curriculum	Compulsory Module (Communication Technology)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Eduard Siemens						
Teaching Staff	Prof. Dr. Eduard Siemens, Mr. Fred Runge						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	3 hours per week per semester (2.25 h)	**Practical training**	1 hours per week per semester (0.75 h)	
Workload	Workload 125 hours, of which 45 in presence and 80 self-study						
Contents	• Introduction: Mobile communication as part of modern information infrastructure • Concept of a cellular mobile radio system using GSM 900 / 1800 as an example: Cell structure, channel structure of the radio interface, modulation on the radio channel, logical channels, their tasks, concept of meta-signaling • Network elements of the GSM network: BSS, NSS, mobile device • Voice codecs for mobile communication • IMSI catcher • Special features UMTS • WLAN, Bluetooth - modulation methods, channel acces and connection control						

Course Objectives and Targeted Competencies	**Professional Competencies:** Students will have an in-depth understanding of the operating principles of wireless cellular networks. They will be able to plan the frequency allocation for a GSM - or UMTS - network. Students will be able to classify the medium into physical and logical speech and signaling channels and apply the concept of meta-signaling to other areas of communication technology. You are able to set up an infrastructure-based as well as an ad-hoc WLAN network and to put it into operation under Linux and MS Windows as well as to perform performance measurements in such networks. Students have knowledge of basic characteristics of modern access devices for mobile and long-distance communication. You will have the ability to perform appropriate network planning for a given deployment scenario and calculate network and duct capacity. **Interdisciplinary Competencies:**
Hardware and Software used	Computer running Linux, an Etehrnet-based transmission system with a network impairment emulator, a Pyhton programming environment
Literature and Sources	Slides, blackboard, scripts as PDF documents, video material Schäfer, Günter; Network security: Fundamentals and Protocols; dPunkt-Verlag (2014) Sauter; Basic Course Mobile Communication Systems; Springer Verlag (2018) Yahya: LTE-A Cellular Networks; Springer (2017)

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Written assignments; lab assignments; Type of examination: Written exam		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Written exam 100 %
Notes	**Taught in English**		

Module	Virtual, Mixed and Augmented Reality - Principles and Practice						
General Data							
ID	**MET_E1_AEK**						
Study programs	MET			**Regular semester**	Summer term		
Module Frequency	every semester			**Duration**	1 semester		
Assignment to the curriculum	Elective module (all focal points)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Dr.-Ing. Johannes Tümler						
Teaching Staff	Prof. Dr.-Ing. Johannes Tümler						
Requirements	**No formal prerequisites**; basic courses on computer science, programming in bachelor's program						
Class	**Lecture**	0	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	Workload 125 h, of which 45 in presence and 80 self-study						
Contents	- Fundamentals of AR/VR (presence, immersion, interactivity, visualization techniques, tracking, displays, software, etc.) - Application areas of AR/VR technologies (application domains, advantages/disadvantages, challenges for users and companies) - Build a basic virtual reality application (Unity, Windows Mixed Reality, SteamVR, OpenVR, Visual Studio) - Create a basic augmented reality application (Unity, HoloLens 2, Android, Vuforia, Visual Studio) - Interaction with virtual elements in AR/VR (Collider, Physics)						

Course Objectives and Targeted Competencies	**Professional Competencies:** Students gain insight into hardware and software fundamentals, human perceptual processes, and standard tools for virtual and augmented reality. They will learn to identify AR/VR technologies and tools and to select suitable AR/VR tools and methods depending on the use case. Students will be able to implement their own low-function AR/VR demos and evaluate the suitability of these demos for the application scenario. **Interdisciplinary Competencies:** - Combined teaching of methodological/technical/economic correlations reinforces analytical ability and deduction - Increase of own creativity and media competence by designing and presenting lectures in modern presentation forms (e.g. Pecha Kucha) - Promotion of social skills through regular cooperative work in small groups - Strengthening of own conflict and communication skills through joint assessment of lecture and practical training performances - Self-responsible work at individual (group dynamic) speeds in the processing of practical tasks results in strengthened decision competence - Collaboration with students from other degree programs
Hardware and Software used	AR glasses, VR glasses, PC, smartphone, Unity, Sketchup, Blender, etc.
Literature and Sources	- Lecture notes and videos for lectures and practical training - Pangilinan et al: Creating Augmented and Virtual Realities: Theory & Practice for Next-Generation Spatial Computing. O'Reilly, 2019 - Schmalstieg, Hollerer: Augmented Reality: Principles and Practice. Addisson-Wesley, 2016

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: 1 paper; Type of examination: Written exam (120 min.)		
ECTS Credit Points	**5 ECTS**	**Valuation of the Module Grade**	Written exam 100 %
Notes	**Taught in English**		

Module	Machine Learning and AI						
General Data							
ID	MET_E2_AEK						
Study programs	MET		**Regular semester**	Summer term			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	Elective module (all focal points)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Stefan Twieg						
Teaching Staff	Prof. Dr. Stefan Twieg						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	2 hours per week per semester (1.5 h)	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	0 hours per week per semester	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	• Introduction to Machine Learning • Difference between Artificial Intelligence and Machine Learning • Problem definition, derivation of the relevant questions • Model architecture and methods of machine learning incl. graphical methods and artificial intelligence • Preprocessing and standardization of data and feature extraction • Supervised and Unsupervised Learning, • Meaning of the loss function • Training and validation of machine learning algorithms • Classification/ regression, and basic probability/distributions						

Course Objectives and Targeted Competencies	**Professional Competencies:** The students have knowledge about the design and mode of action of machine learning methods and artificial intelligence. They gain the ability to identifiy the relevant information for pattern recognition tasks and understand the mathematical transformations and description forms required. They can analyze given problems and develop and implement systems using machine learning algorithms to solve them. Students gain detailed knowledge and the ability to implement and document machine learning algorithms in software. **Interdisciplinary Competencies:** Group work in the practical part challenges and promotes the students' ability to work in a team and their social skills.
Hardware and Software used	Computer, Office, Meters, Experiments, Raspberry Pi, Linux, Python
Literature and Sources	• Bishop, C. M.: Pattern Recognition and Machine Learning. Springer Verlag • Hastie, Trevor (et al.): The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer Verlag • MacKay, David J.C.: Information Theory, Inference and Learning Algorithms. Cambridge Uni. Press • Kruse, R. (et al.): Computational Intelligence, Eine methodische Einführung in Künstliche Neuronale Netze, Evolutionäre Algorithmen, Fuzzy- Systeme und Bayes-Netze. Springer Verlag

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Exercises; Type of examination: Paper or presentation		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Paper or presentation 100%
Notes	**Taught in English**		

Module	Internet Security						
General Data							
ID	**MET_E3_AEK**						
Study programs	BMT, EIT, MT			**Regular semester**	Summer term		
Module Frequency	annual			**Duration**	1 semester		
Assignment to the curriculum	Elective module (all focal points)			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	Prof. Dr.-Ing. Ingo Chmielewski						
Teaching Staff	Prof. Dr.-Ing. Ingo Chmielewski, Dipl.-Ing. Fred Runge						
Requirements	**No formal prerequisites**; Module "Mathematics I and II", Computer Networks (or comparable)						
Class	**Lecture**	2 hours per week per semester (1.5 h)	**Exercise/Seminar**		**Practical training**	2 hours per week per semester (1.5 h)	
Workload	125 hours in total, of which 45 hours in presence and 80 hours in self-study						
Contents	• Introduction and examples: Internet Worm versus Slammer, Stuxnet, Snowden • Technical Attacks: Basics of attack analysis, threats, attacks, vulnerabilities, denial of service, malicious code, email security, mobile code, system-based attacks, web/net-based attacks, vulnerability assessment (CVSS) • Social Engineering: Human Factor in IT Security, Digital Carelessness • Network security - layer 2: Data Link Layer, Point-to-Point Protocol (PPP), Point-to-Point Tunneling Protocol (PPTP), Layer 2 Tunneling Protocol (L2TP), IEEE 802.1x • WLAN security: WEP, WPA, WPA2 • Layer 3: Network Layer, IP threats and weaknesses, IPSec, key distribution with IKE • Layer 4 - Transport Layer, TCP / UDP, Secure Socket Layer / Transport Layer, Security (SSL/TLS) • Layer 7: Secure Shell (ssh), SSH v1 versus SSH v2, protocol architecture						

Course Objectives and Targeted Competencies	**Professional Competencies:** The aim of the module is to provide a basic understanding of concepts, methods and terminology of data protection, data security and cyber security. In particular, the concepts of encryption procedures and their practical application should be understood. One focus is on providing basic knowledge for understanding IT security as a process. Furthermore, basic knowledge of network security in the different layers of the OSI layer model and the respective application possibilities in IT are taught. Practically relevant problems of data protection and data security are discussed, which are of fundamental importance for the everyday professional life of an engineer. **Interdisciplinary Competencies:** Based on OSI layer model, the data protocols existing here were understood in terms of security and attack scenarios		
Hardware and Software used	Laboratory PCs with OS Linux and Raspberry Pi		
Literature and Sources	• Brenner M., gentschen Felde, N., Hommel, W., Metzger, S., Reiser, H., Schaaf, T. Praxisbuch ISO/IEC 27001 - Management der Informationssicherheit And preparation for certification, 2. Auflage, Hanser, 2017 • Reiser, Helmut, Lecture Notes IT Security, Landesrechenzentrum München • Baun, Christian, Lecture Notes Fundamentals of Computer Science, Darmstadt University of Applied Sciences • Claudia Eckert: IT Security - Concepts - Procedures - Protocols. Oldenbourg, Munich, 2001. • Bruce Schneier: Angewandte Kryptographie – Protokolle, Algorithmen und Sourcecode in C, Addison-Wesley, 1996.		
Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts, practical training; Type of examination: Paper		
ECTS Credit Points	**5 ECTS**	**Valuation of the Module Grade**	Paper 100 %
Notes	**Taught in English**		

Module	Advanced Network Administration						
General Data							
ID	MET_E4_K						
Study programs	MET		**Regular semester**	2. Semester			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	**Elective module (Communication Technology)**		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	**Prof. Dr. Eduard Siemens**						
Teaching Staff	**Prof. Dr. Eduard Siemens, Dipl.-Ing. Fred Runge**						
Requirements	**No formal prerequisites; professional prerequisites:** Knowledge of computer networks, knowledge of Ethernet and IP networks						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	1 hours per week per semester (0.75 h)	**Practical training**	3 hours per week per semester (2.25 h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	Design and implementation of a complex custom IP network task. Analysis and test of the performance and security architecture of the realized task. The assignment will be assigned to the student individually or in a group of up to three students from the current research topics of the Future Internet Lab Anhalt. Programming languages like Python, C/C++ and BASH are used together with Unix tools.						
Course Objectives and Targeted Competencies	**Professional / Interdisciplinary Competencies:** Students are able to analyze a complex IT task, divide it into several manageable subtasks and work on these alone or in a small work group. They have the capability to examine, test and evaluate the security architecture. Furthermore, they are able to describe and graphically represent the realized network configuration and to compare, present and defend the elaborated concepts in the context of current developments.						
Key Qualifications	Network administration, software development, security architecture						
Hardware and Software used	Computers, Linux-based PC servers, network implairment emulators, Ethernet switches, IP routers						
Literature and Sources	Slide presentation, video material, various internet resources						

Module Activities and Credits							
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Practical assignments; Type of examination: Term paper						
ECTS Credit Points	5 ECTS points			**Valuation of the Module Grade**	Term paper 100 %		
Notes	**Taught in English**						
Module	**Interdisciplinary Project**						

General Data			
ID	MET_E5_AEK		
Study programs	MET	**Regular semester**	Every semester
Module Frequency	Annual	**Duration**	1 semester
Assignment to the curriculum	Elective module (all focal points)	**Associated examination and degree program regulations**	SPO MET 16.09.2020

Module-specific data							
Responsible for the module	Prof. Dr. Marc Enzmann						
Teaching Staff	Lecturers of the department						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	0 hours per week per semester	**Practical training**	0 hours per week per semester	
Workload	125 hours in total, thereof 125 self-study hours						
Contents	By arrangement: Students demonstrate the ability to independently analyze a scientific/technical issue, develop a solution, and elaborate the solution. They will discuss the results with the supervising university professor and discuss advantages and disadvantages of different approaches.						

Course Objectives and Targeted Competencies	**Interdisciplinary Competencies:** Students can - independently, alone or in small groups, present, structure, and evaluate a scientific or technical topic in writing and orally in a limited amount of time, - Name and apply rules of care in the preparation of scientific papers and/or presentations, - Plan and independently perform work steps in the creation of scientific or technical work, - Conduct literature research independently, critically evaluate literature sources and apply citation methods (also in presentations), - Use software to create project work and presentations (including literature management programs, if applicable), - Implement techniques of good scientific presentations, - Design group work in a goal-oriented manner, - Apply feedback rules and reflect their own way of working.
Hardware and Software used	
Literature and Sources	

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Type of examination: Draft/Paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Draft/Paper: 100%
Notes	**Taught in English**		

Module	Mechatronics						
General Data							
ID	MET_E6_A						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency			**Duration**	1 semester			
Assignment to the curriculum	Elective Module (Automation)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Marc Enzmann						
Teaching Staff	Prof. Dr. Marc Enzmann						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	4 hours per week per semester (3 h)	**Practical training**	0 hours per week per semester	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	- Mechatronic systems - Modeling of mechanical systems - Process analysis of mechatronic systems - Design of mechatronic systems - Tool-supported modeling and simulation - Design and calculation of selected systems						

Course Objectives and Targeted Competencies	**Professional Competencies:** Students understand mechatronics as an interdisciplinary field of knowledge and work. They have in-depth knowledge of model building and analysis as well as of the simulation and calculation tools Matlab/Simulink. Students acquire knowledge of the development process for mechatronic systems according to VDI guideline 2206. Using examples from the automotive industry, students develop the ability to mathematically describe typical components of mechatronic systems, such as actuators, sensors and basic mechanical structures, to program and simulate them in Matlab/Simulink, and to assemble and simulate components to form the overall system and analyze the results. **Interdisciplinary Competencies:** Participants gain the ability to critically analyze their own and third-party simulation models and to validate or verificate simulation models. They deepen their competence in structuring and penetrating interdisciplinary tasks and solving them using modern simulation tools.
Hardware and Software used	Matlab / Simulink respectively Scilab/Scicos
Literature and Sources	- Bolton: Bausteine mechatronischer Systeme; Pearson Verlag - Roddeck: Einführung in die Mechatronik, Vieweg+Teubner - Borutzky: Bond Graphs for Modeling, Control and Fault Diagnosis of Engineering Systems; Springer

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts, simulation models; Type of examination: Term Paper and Presentation;		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Term paper 80%, presentation 20%
Notes	**Taught in English**		

Module	Sensor and Actuator Technology						
General Data							
ID	MET_E6_AE						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency			**Duration**	1 semester			
Assignment to the curriculum	Elective Modules (Automation, Embedded Systems)		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Hannes Kurtze						
Teaching Staff	N.N.						
Requirements	**No formal prerequisites;**						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (3 h)	**Practical training**	0 hours per week per semester	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	• Introduction: Sensors and actuators, measured variables, characteristics • Use, stability, reliability, lifetime of sensors • Physical, crystallographic and microtechnological fundamentals of solids • Physical effects and mechanical sensors: Force and pressure sensors, rotation rate measurement, acceleration measurement • Microsystem technology and actuator engineering • Length measurement, ultrasonic sensors • Filling level and flow measurement • Particle measurement technology • Physical principles of the detection of electromagnetic waves • Photodiodes, photoresistors, magnetic sensors • Physical principles of temperature measurement, thermocouples, temperature resistors • Gas pressure and vacuum measurement technology • Gas sensors, wet sensors, sensors for explosives						

Course Objectives and Targeted Competencies	**Professional Competencies:** The students know the basic physical effects used for sensor and actuator technology and master the various measurement principles. They have knowledge of sensor designs, application conditions and reliability, of manufacturing processes for sensors (micro and nano system technology, coating techniques, etching techniques) as well as of concrete application possibilities. They have methodological competence for industrial problem solving by applying and combining different sensor techniques. **Interdisciplinary Competencies:** The students have the ability to use the acquired knowledge in the professional environment for the selection, dimensioning and process integration of a sensor system
Hardware and Software used	
Literature and Sources	• Tränkler, Obermeier: Sensortechnik; Springer-Verlag • Herold: Sensortechnik; Hüthig Verlag • Webster: The measurement, instrumentation and sensors; CRC Press • Köhler: Nanotechnologie; Wiley Verlag • Merz, Mohr: Mikrosystemtechnik für Ingenieure; Wiley Verlag

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Practical training, paper; Type of examination: Oral examination (20 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Oral exam 100 %
Notes	**Taught in English**		

Module	Systems Programming						
General Data							
ID	MET_E8_AEK						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	**Elective module (all focal points)**		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	Prof. Dr. Ingo Chmielewski						
Teaching Staff	Prof. Dr. Ingo Chmielewski						
Requirements	**No formal prerequisites**; **professional prerequisites**: Programming knowledge in C						
Class	**Lecture**	0 hours per week per semester	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	2 hours per week per semester (1.5 h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	System programming using Linux userspace application interacting with the system resources Use of I/O concepts, process and memory management multi- threading and multiprocessing						
Course Objectives and Targeted Competencies	**Professional Competencies:** Students have understood the function and interactions of the structural layers of a modern operating system and are able to develop their own small userspace applications. They can use the available system resources in a targeted manner and, if necessary, are able to interpret and correct system misbehavior. Participants will be able to perform efficient programming using system resources for applications using Linux as an example. **Interdisciplinary Competencies:** The group work in the practical training demands and promotes the students' ability to work in a team and their social competence.						
Hardware and Software used	BeagleBone, RaspberryPi, Lab PC with OS Linux						

Literature and Sources	R. Love: Linux System Programming (2nd Edition), 2013 M. Kerrisk: The Linux Programming Interface: A Linux and UNIX System Programming, 2010 R. E. Bryant, D. R. O'Hallaron: Computer Systems: A Programmer's Perspective (3rd Edition), 2015

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Drafts, programming assignments; Type of examination: Written exam (120 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Written exam 100 %
Notes	**Taught in English**		

Module	Optoelectronics						
General Data							
ID	MET_E9_AEK						
Study programs	MET		**Regular semester**	Winter term			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	**Elective module (all focal points)**		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	**Prof. Dr. Hannes Kurtze**						
Teaching Staff	**Prof. Dr. Hannes Kurtze, M.Sc. Torsten Büchner**						
Requirements	**No formal prerequisites; professional prerequisites:** Basic knowledge mathematics and physics						
Class	**Lecture**	2 hours per week per semester (1.5 h)	**Exercise/Seminar**	1 hours per week per semester (0,75h)	**Practical training**	1 hours per week per semester (0,75h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	• Design and application of optical fibers, data transmission and limits. • Semiconductor materials (e.g. Si, GaAs, InSb), pn-junction • Sensors (photodiode, CCD) and emitting devices (RCLED, SLED, VCSEL) • Selected advanced methods • Semiconductor devices of reduced dimensions (e.g. quantum well, quantum dot) • Efficiency and temperature behavior, emission properties of lasers vs. thermal light sources • Applications in media and communications technology as well as biomedical technology (e.g. optical data transmission, pulse oximetry)						
Course Objectives and Targeted Competencies	**Professional Competencies:** The students obtain an overview of optoelectronic devices and optical data transmission and can explain their principles and relevant methods. The students can understand and explain basic relations, such as basic semiconductor optics up to selected methods of quantum optical phenomena (e.g. stimulated and spontaneous emission). They can describe technical solutions, derive approximations and judge optical components, relevant designs and materials for a given application. The students are able to prepare, to conduct and to analyze relevant experiments. The students are able to measure relevant parameters and to make a critical assessment of their own findings. **Interdisciplinary Competencies:** Optoelectronic devices and optical data transmission. Working principles of light emiting devices (lasers) and optical detectors. Advanced methods in optoelectronics (reduced dimensions).						
Hardware and Software used	Experiments, lab equipment (e.g. laser, oscilloscope,...), spreadsheet and word processing applications						

Literature and Sources	• Pedrotti et al: Introduction to Optics, Pearson / Optik für Ingenieure, Springer • Eichler et al: Laser, Springer • Thuselt: Physik der Halbleiterbauelemente, Springer • Saleh and Teich, Fundamentals of Photonics, Wiley

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Practical training; Type of examination: Written exam (120 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Written exam 100%.
Notes	**Taught in English**		

Module	German Language						
General Data							
ID	MET_E10_AEK						
Study programs	MET			**Regular semester**	Winter semester / Summer semester		
Module Frequency	**Annual**			**Duration**	1 semester		
Assignment to the curriculum	**Elective Module (Non-technical)**			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	**Antje Fechner (Language Center)**						
Teaching Staff	**Antje Fechner**						
Requirements	**No formal requirements;**						
Class	**Lecture**	0 hours per week per semester (1.5 h)	**Exercise/Seminar**	4 hours per week per semester (3.0 h)	**Practical training**	0 hours per week per semester (0h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	-Basics of the German Language:						
Course Objectives and Targeted Competencies	Depending on students' prior knowledge: - Fundamentals/extension of the four basic skills: Writing, speaking, listening, reading - Fundamentals/extension of knowledge of German grammar and application to written texts/spoken texts - Fundamentals/expansion of the ability to understand written and spoken texts - Improving the ability to communicate in German - Increase of the vocabulary						
Hardware and Software used							
Literature and Sources	• Buscha / Szita: Begegnungen: Deutsch als Fremdsprache (A1); Schubert-Verlag • Buscha / Szita: Begegnungen: Deutsch als Fremdsprache (A2); Schubert-Verlag • Buscha / Szita: Spektrum Deutsch: integriertes Kurs- und Arbeitsbuch für Deutsch als Fremdsprache (B1+); Schubert-Verlag						
Module Activities and Credits							
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Practical training; Type of examination: Oral examination (20 min.)						
ECTS Credit Points	5 ECTS points			**Valuation of the Module Grade**	Oral exam 100%.		
Notes	**Taught in English**						

Module	Engineering Ethics						
General Data							
ID	MET_E11_AEK						
Study programs	MET			**Regular semester**	Winter semester / Summer semester		
Module Frequency	**Annual**			**Duration**	1 semester		
Assignment to the curriculum	**Elective Module (Non-technical)**			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	**Prof. Dr. Jens Hartmann**						
Teaching Staff	**Prof. Dr. Jens Hartmann, Prof. Dr. Hannes Kurtze, Prof. Dr. Fabian Herz**						
Requirements	**No formal requirements;**						
Class	**Lecture**	0 hours per week per semester (1.5 h)	**Exercise/Seminar**	4 hours per week per semester (3 h)	**Practical training**	0 hours per week per semester (0h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	• Responsibility and technology • Technical opportunities and risks using the example of life sciences (e.g. genetic engineering) • Responsibility of engineers • Case studies for discussion (water use and drinking water sanitation, limits of nanotechnology; environmental technology and environmental awareness)						
Course Objectives and Targeted Competencies	The aim of the module is to confront and sensitize students of all courses of the department (Life Science Engineering) with ethical principles and problems in their future engineering activity and to give guidelines as orientation in ethical and moral questions. In addition to general engineering principles and concepts (progress, sustainability, responsibility), the focus is particularly on the theory of consequential ethics in the context of technical innovations in the life science sector (e.g. environment, societal consequences, acceptance and participation). The growth-driven society with a constant yield maximization should be countered by a professional code of engineering that discusses concepts such as safety/risk, sustainability, environmental protection and the courage to turn things around in a series of decisions and introduces them into the future society. Thus, discourse between instructors and students is at the forefront of teaching styles. Students will use numerous case studies to inform, discuss, and make decisions or comment on them. Thus, teaching success here depends critically on student activity. This activity is to be increased by most different offers in the methodology.						
Hardware and Software used							

Literature and Sources	• L. Hieber, H.-U. Kammeyer: Verantwortung von Ingenieurinnen und Ingenieuren; Springer(2014) • A. Grunwald, M. Simonidis-Puschmann: Technikethik-Handbuch J. B. Metzler-Verlag (2013) • F. Stähli: Ingenieurethik an Fachhochschulen; Fortis-Verlag (1994). • S. Latonche Es reicht-Abrechnung mit dem Wachstumswahn; oekam 2015

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Type of examination: Term paper		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Term paper 100%.
Notes	**Taught in English**		

Module	Quality Assurance Expert						
General Data							
ID	MET_E12_AEK						
Study programs	MET			**Regular semester**	Winter semester / Summer semester		
Module Frequency	**Annual**			**Duration**	1 semester		
Assignment to the curriculum	**Elective Module (Non-technical)**			**Associated examination and degree program regulations**	SPO MET 16.09.2020		
Module-specific data							
Responsible for the module	**Christine Ihloff**						
Teaching Staff	**Christine Ihloff**						
Requirements	**No formal requirements;**						
Class	**Lecture**	2 hours per week per semester (1.5 h)	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	1 hours per week per semester (0,75h)	
Workload	125 hours in total, of which 56.25 in presence and 68.75 in self-study						
Contents	• Management systems in the company • Quality management systems - requirements • Structure / Introduction / Certification / Accreditation of QMS • Quality management along the product life cycle • Methods and tools of QM						
Course Objectives and Targeted Competencies	Students learn the importance of a comprehensive quality management system for the long-term success of the company. They will be enabled to introduce or support a quality management system in companies. They develop a deep understanding of the application of relevant cross-industry and specific laws and standards as a prerequisite for the targeted fulfillment of the requirements set out therein. The use of various elementary methods and tools of quality management forms the core of the exercises, in which the procedure is trained in depth using practical examples. Students regularly present the results of their group work during seminars.						
Hardware and Software used							
Literature and Sources	• Lecture notes • Qualitätsmangement für Ingenieure; Gerhard Linß; HANSER-Verlag • Qualität und Zuverlässigkeit - Zeitschri\ HANSER-Verlag • aktuelle Normen, Richtlinien, Gesetze QM betreffend						

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Type of examination: oral examination (20 min.)		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Oral exam 100%.
Notes	**Taught in English**		

Module	Project Management and Quality Assurance

General Data			
ID	MET_E13_AEK	Language	German
Study programs	MET	Regular semester	Summer term
Module Frequency	1 x yearly	Duration	1 semester
Assignment to the curriculum	Elective module (all focal points)	Associated examination and degree program regulations	SPO MET 16.09.2020

Module-specific data							
Responsible for the module	Prof. Dr. Jürgen Röper						
Teaching Staff	Prof. Dr. Jürgen Röper						
Requirements	No formal requirements;						
Class	Lecture	2 hours per week per semester (1.5 h)	Exercise/Seminar	2 hours per week per semester (1.5 h)	Practical training	0 hours per week per semester (0.0 h)	
Workload	Workload of 125 hours, including 45.00 hours of presence and 80.00 hours of self-study.						
Contents	Quality management ISO 9001: Structure and core contents ; QM practice methods from the areas of quality planning, control, assurance and -improvement such as CTQ, Kano, FMEA, control plan, process capability, control chart, PDCA; classic project management: Processes for initiating, definition, planning, controlling and closing projects; agile project management: Preparation and implementation of projects using SCRUM model; network technique: Creation of network plans and their use for planning and for the control of projects						
Course Objectives and Targeted Competencies	The students are familiar with the design and application of the DIN EN ISO 9001 quality management system. Methodologically, they are able to select and apply tools for planning, controlling, assuring and improving the quality of products and processes. For the value-added implementation of projects in business practice, students acquire knowledge of the definition, planning, execution and completion of projects. They acquire basic qualifications in the methodology and practical application of classic and agile project management.The students know the design and application of the quality management system DIN EN ISO 9001. Methodologically, they are able to select and apply tools for planning, controlling, assuring and improving the quality of products and processes. For the value-added implementation of projects in business practice, students acquire knowledge of the definition, planning, execution and completion of projects. They will acquire fundamental qualifications in the methodology and practical application of classic and agile project management.						
Hardware and software used							

Literature and	• Lecture notes • G. Winz, Qualitätsmanagement für Wirtschafsingenieure, Hanser Verlag, 2016. • G. Linß, Qualitätsmanagement für Ingenieure, Fachbuchverlag Leipzig, 2018. • H. Brueggemann. P. Bremer, Grundlagen Qualitätsmanagement, Springer 2015. • G.F. Kamiske [ed.], Handbuch QM-Methoden, Hanser, 2015. • M. Burghardt, Leitfaden für Planung, Überwachung und Steuerung in Projekten, John Wiley ,2012. • R. Felkai, Projektmanagement für technische Projekte , Springer Vieweg, Wiesbaden, 2015. • J. Kuster et al., Handbuch Projektmanagement Agil – Klassisch – Hybrid, Springer Gabler, Berlin 2019. • K. Olfert, Kompakt-Training Projektmanagement, Kiehl Friedrich Verlag, 2014. • U. Kusay-Merkle, Agiles Projektmanagement im Berufsalltag, Springer Gabler 2018. • D. Maximini, Scrum - Einführung in der Unternehmenspraxis, Berlin, Springer Gabler 2018.

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: (Practical training, exercises, paper); type of examination: Written exam, duration 120 minutes;		
ECTS Credit Points	5	Valuation of the Module Grade	Written exam 100 %
Notes	**Taught in English**		

Module	Business Start Up						
General Data							
ID	MET_E14_AEK						
Study programs	MET		**Regular semester**	Winter semester / Summer semester			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	**Elective Module (Non-technical)**		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	**Prof. Dr. Carsten Fussan**						
Teaching Staff	**Prof. Dr. Carsten Fussan**						
Requirements	**No formal requirements;**						
Class	**Lecture**	2 hours per week per semester (1.5 h)	**Exercise/Seminar**	2 hours per week per semester (1.5 h)	**Practical training**	0 hours per week per semester (0,0h)	
Workload	125 hours in total, of which 45 in presence and 80 in self-study						
Contents	• Management systems in the company • Quality management systems - requirements • Structure / Introduction / Certification / Accreditation of QMS • Quality management along the product life cycle • Methods and tools of QM						

Course Objectives and Targeted Competencies	During the course, participants will gain insight into different aspects of entrepreneurial future planning. Both the structural and financial effects of innovation transfers into new business areas of existing companies as well as into start-ups are to be understood by the students and practiced in the context of their own planning simulation. Of particular importance here is the acquisition by students of fundamental perspectives on competition economics. The analysis of core competencies relevant to start-ups, competitive analyses as well as methods for the definition of niches, the development of competitive business models and process analytical competencies should be understood by the students and complement their business skills, regardless of whether the career perspective of "self-employment" or "employment" is pursued after university. The skills taught are therefore aimed both, starting a career in a company or preparing students to set up their own independent, economically viable business. **Interdisciplinary Competencies:** Recognition of basic business patterns for successful innovation transfers; understanding of the significance of entrepreneurship activities and their classification in the context of science; application of methodological knowledge and development of transfer services; strengthening of self- and personal competence through assumption of responsibility and self-organization during the preparation of documents; ability to lecture and media competence through regular presentations of the work packages
Hardware and Software used	MS Office
Literature and Sources	• E-Entrepreneurship : Grundlagen der Unternehmensgründung in der Digitalen Wirtscha\ (Tobias Kollmann) 2019 • Der Businessplan : Geschäftspläne professionell erstellen. Mit Checklisten und Fallbeispielen (Anna Nagl) 2018 • Gründen mit Erfolg : Das eigene Startup-Unternehmen (Anabel Ternès von Hattburg, Juliane Reiber) 2020 • Lecture notes

Module Activities and Credits			
Mandatory Examination Prerequisites | Type of examination	Mandatory Examination Prerequisites: Exercise assignments, drafts; Type of examination: Term paper / Presentation		
ECTS Credit Points	5 ECTS points	**Valuation of the Module Grade**	Term paper 80%; presentation 20%
Notes			

Module	Master Thesis						
General Data							
ID	MET_03_01_MAEK						
Study programs	MET		**Regular semester**	Winter semester / Summer semester			
Module Frequency	**Annual**		**Duration**	1 semester			
Assignment to the curriculum	**Compulsory Module (all focal points)**		**Associated examination and degree program regulations**	SPO MET 16.09.2020			
Module-specific data							
Responsible for the module	**Prof. Dr. Marc Enzmann**						
Teaching Staff	**All teachers of the department**						
Requirements	**Formal prerequisites:** Admission according to §8 “Studiengangsspezifische Bestimmungen”						
Class	**Lecture**	0 hours per week per semester (1.5 h)	**Exercise/Seminar**	0 hours per week per semester (0.0 h)	**Practical training**	0 hours per week per semester (0h)	
Workload	Total effort 750 hours						
Contents	In-depth work on a current or fundamental topic in a working group of the department or a research institution or in a company with the preparation of a work plan, literature research, preparation of the experimental designs, familiarization with the corresponding methodology, documentation of the results, data evaluation, discussion of the results taking into account scientific publications, preparation of a master's thesis as well as oral presentation and defense of the thesis.						
Course Objectives and Targeted Competencies	In this module, students are expected to produce a scientific paper that demonstrates that they are able to independently work on a task from the field of chemistry using scientific methods within a given period of time, as well as to display and critically discuss the results in written form. In addition, students should demonstrate that they can defend their own work in a public scientific discussion.						
Hardware and Software used							
Literature and Sources							
Module Activities and Credits							
Mandatory Examination Prerequisites | Type of examination	Type of examination: Written work / Colloquium						
ECTS Credit Points	27 ECTS points (written work) + 3 ECTS (colloqium)		**Valuation of the Module Grade**				