

**Akkreditierungsantrag
der
Hochschule Bremen**

**>>Electronics Engineering M.Sc. <<
„Teil E - Modulhandbuch“**

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1.1 Material Science (MSC)

Module code	1.1 in MSE
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Semester	Winter semester
Module coordinator	Prof. Dr. rer.nat. Ludger Kempen
Qualification objectives	<p>This module provides specific knowledge of materials science needed in the field of microelectronics and microsystem engineering. Key aspects are semiconductor physics, thin films and material properties important for microsystem applications. Special aspects are reinforced in laboratory experiments</p> <p>After completion of this course the students are able to</p> <ul style="list-style-type: none"> • understand the physical concept leading to different kinds of solids • apply the concept of entropy to different applications like phase diagrams, crystalline imperfections and ordered states • work with phase diagrams • derive semiconductor properties from band model • select optimal materials for microsystem applications • identify the influence of deposition parameters on materials properties of thin films • conduct, interpret and document experiments in a scientific way
Syllabus	<ul style="list-style-type: none"> • Atoms and bonding • Structure of solids • Influence of imperfections on crystalline solids • Entropy, thermal equilibrium and kinetics • Diffusion in solids • Phase diagrams • Conductivity and band model of solids • Dielectric, magnetic and optical properties • Deposition techniques and properties of thin films
Type of module	Core module in MSE, compulsory optional module in MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work

Pre-requisites	No specific pre-conditions
Usability	
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	W. D. Callister, <i>Materials Science and Engineering: An Introduction</i> , Wiley, 2014

Courses		
Lecturer	Title of the course	Hours per week and semester
Kempen	Material Science (S)	2
Kempen	Material Science (L)	2

1.2 Concept Engineering for Mixed-Technology Systems (CEMS)

Module code	1.2 in MSE
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Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Mirco Meiners
Qualification objectives	<p>The objective of this module is to introduce the students into the basic principles, challenges and limitations of concept engineering for mixed-technology systems.</p> <p>After completion of this module the students have acquired a thorough understanding of</p> <ul style="list-style-type: none"> • Mixed-technology systems <ul style="list-style-type: none"> - Interfacing Systems on Chip (SoC) - Inertial systems, accelerometers, gyroscopes - Thermal or gaseous systems - Piezo systems • Design Methodology <ul style="list-style-type: none"> - Seamlessly modeling and design over all physical domains • Concept Engineering ASICs <ul style="list-style-type: none"> - Partitioning • Packaging
Syllabus	<ul style="list-style-type: none"> • Analysing and designing systems on behavioural and circuit level with MATLAB/SIMULINK • SPICE and HDL like VHDL-AMS and Verilog-ams
Type of module	Core module in MSE, compulsory optional module in MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120

Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	A concurrent reference list will be offered in the beginning of the course on AULIS.

Courses		
Lecturer	Title of the course	Hours per week and semester
Meiners	Concept Engineering for Mixed-Technology Systems (S)	2
Meiners	Concept Engineering for Mixed-Technology Systems (L)	2

1.1 Measurement and Instrumentation (MIN)

Module leader:	Prof. Dr.-Ing. Friedrich Fleischmann			
ECTS points:	6 ECTS	Workload (h):	180h	
Type of module and position in the course of study:	Mandatory module taught in the 2. semester	Contact hours (h):	56h	
Scope und frequency of teaching:	14 classes in winter term	Self-study (h):	124h	
Type of module and position in other study programs or continuing education offers:	Mandatory module in the 2. semester of the study program <i>short form</i>			
Learning outcomes:				
Knowledge and understanding (extension, consolidation and understanding of knowledge) <ul style="list-style-type: none"> distinguish between different classes of sensors are aware of the impact of mathematical basics of probability theory know principles of design of experiments are able to use NIST-GUM 				
Using, applying and generating knowledge (applying and transferring knowledge, Scientific innovation) <ul style="list-style-type: none"> apply statistical methods to evaluate significance of measurement results assess decisive characteristics of acquisition hardware develop signal conditioning HW/SW apply systemic thinking in systems design including aspects of EMI control design meaningful experiments 				
Communication and cooperation <ul style="list-style-type: none"> do project work in a team decide autonomous about organization and conduct of experiments present progress and results to supervisors and peers assess results from experiment, evaluate in team and document scientifically 				
Reflection of academic and professional identity <ul style="list-style-type: none"> reflect system design and test setup with regard to alternative designs adhere to standards of professional action and documentation 				
Course content:				
<ul style="list-style-type: none"> ANOVA, MANOVA, Hypothesis testing Uncertainty in measurement Design of experiments EMC/EMI in measurement applications Interfaces and bus systems Sensor signal conditioning Examples of electrical measurement of non-electrical properties 				
Language of teaching:	English			
Prerequisites:	None			
Preparation/literature:	Students will receive a reading list at the beginning of the semester.			
Further information:	E.g. link to Aulis, if applicable			
Courses of the module				
Course title	Teaching staff	Contact hours per week	Learning and teaching methods	Examination method(s), scope and duration
Measurement and Instrumentation (S)	Fleischmann	2	Seminar	Presentation

Measurement and Instrumentation (L)	Fleischmann	2	Exp. lab work	(30 min) and written report (60%). Scientific experimental work incl. documentation (40%)
Bachelor programs only: Module-related tutorial				

1.4 Laser Systems and Applications (LSA)

Module code	1.2 in ISI
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Semester	Winter semester
Module coordinator	Prof. Dr. rer.nat. Thomas Henning
Qualification objectives	<p>This module conveys systematic skills to design and apply laser systems.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • distinguish between different types of laser systems and typical laser applications in fields of medicine, metrology and material processing • determine laser systems for specific applications • integrate components into a laser system • evaluate quality of a laser system with respect to a given application • design optical beam shaping systems for adjusting laser radiation to a specific application • do project work in an international team of engineers with different scientific background (Optics, Electronics, Materials, Communications, Metrology)
Syllabus	<ul style="list-style-type: none"> • Typical laser applications: laser cleaning, rapid prototyping, medical applications, laser annealing • Characterization of laser radiation • Development of beam delivery and beam shaping systems • Application of short pulse laser systems • Generation of short pulses • Laser micro processing • Optical metrology and spectroscopy
Type of module	Core module in MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions

Usability

Student workload 60 + 120

Contact hours 60

Independent study 120

ECTS points 6

Duration and frequency Once per study year / 15 Terms

Language English

Reading list
 A.E. Siegman: *Lasers*, University Science Book
 O. Svelto: *Principles of Lasers*, Plenum Press
 M. Young: *Optics and Lasers*, Springer
 J. Eichler, H.J. Eichler: *Laser*, Springer

Courses		
Lecturer	Title of the course	Hours per week and semester
Henning	Laser Systems and Applications (S)	2
Henning	Laser Systems and Applications (L)	2

1.5 Stochastic Signals and Systems (SSS)

Module code	1.1 in CSE
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Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	<p>The objective of this module is to introduce the students into the basic principles of probability theory, stochastic processes and optimal filtering as required for applications in communication, control as well as radar and sonar signal processing.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • understand the concepts of probability theory and stochastic processes • determine and interpret moments of random variables and moment functions of stochastic processes • select suitable stochastic processes for modeling physical measurements, communication signals, etc. • extend the system theoretic concepts for deterministic input and output signals to stationary stochastic input and output processes • represent and investigate stationary stochastic processes in the frequency domain • specify appropriate optimal filtering approaches for signal-to-noise ratio enhancement as well as state vector estimation and prediction • investigate and assess the aforementioned topics using Matlab
Syllabus	<ul style="list-style-type: none"> • Probability Theory: Random Variables, Distribution Functions, Expectation Operator, Vector-valued Random Variables, Transformations of Random Variables, Convergence Concepts, Laws of Large Numbers, Central Limit Theorems • Stochastic Processes: Fundamentals, Some Particular Processes, Stationary Processes, Stochastic Limiting Operations, Spectral Analysis of Stationary Processes, Systems with Stochastic Inputs, Special Discrete Time Parameter Models • Optimal Filtering: Matched Filtering (White and Colored Noise), Wiener Filtering (Wiener-Hopf Equation, Noncausal and Causal Wiener Filtering), Kalman Filtering (State Space Model, State Estimation, Kalman Approach)
Type of module	Core module in CSE, compulsory optional module in MSE and MAI

Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>D. Kraus, <i>Stochastic Signals and Systems</i>, lecture notes chapter 1, 2 and 6, Hochschule Bremen</p> <p>J.F. Böhme, <i>Stochastische Signale: Eine Einführung in Modelle, Systemtheorie und Statistik mit Übungen und einem MATLAB-Praktikum</i>, Teubner, 1998</p> <p>E. Hänsler, <i>Statistische Signale: Grundlagen und Anwendungen</i>, Springer, 2001</p> <p>A. Papoulis, S.U. Pillai, <i>Probability, Random Variables and Stochastic Processes</i>, McGraw-Hill, 2001</p> <p>S. Kay, <i>Intuitive Probability and Random Processes using MATLAB</i>, Springer, 2006</p>

Courses		
Lecturer	Title of the course	Hours per week and semester
Kraus	Stochastic Signals and Systems (S)	2

Kraus	Stochastic Signals and Systems (L)	2
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1.6 Advanced Digital Signal Processing (ADSP)

Module code	1.2 in CSE
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Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Stefan Wolter
Qualification objectives	<p>This module covers topics of digital signal processing techniques exceeding the fundamentals usually found in a bachelor degree course. It includes e.g. spectral analysis, finite word length effects and multirate signal processing. A key feature of the module is the computer-assisted learning approach using MATLAB and Simulink.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • develop and program algorithms for the computation of the Discrete Fourier Transform • select and apply methods to analyze the spectrum of signals (sinusoidal, non-stationary and random) • analyze the effects of quantization and arithmetic round-off errors and develop optimized fixed-point implementations for digital filters • explain and apply devices for sampling-rate alteration • investigate and design digital filter banks • apply MATLAB and Simulink tools
Syllabus	<ul style="list-style-type: none"> • computation of the Discrete Fourier Transform • spectral analysis of signals • finite word length effects • multirate signal processing
Type of module	Core module in CSE, compulsory optional module in MSE and MAI
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions

Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>Mitra, Digital Signal Processing, McGraw-Hill International Editions</p> <p>Proakis/Manolakis, Digital Signal Processing, Pearson International Edition</p> <p>Kammeyer/Kroschel, Digitale Signalverarbeitung, Vieweg+Teubner Studium</p> <p>Mertins, Signaltheorie, Vieweg+Teubner Studium</p> <p>Vaidyanathan, Multirate Systems and Filter Banks, Prentice-Hall Series in Signal Processing</p> <p>Oppenheim/Schafer/Buck, Zeitdiskrete Signalverarbeitung, Pearson Studium</p>

Courses		
Lecturer	Title of the course	Hours per week and semester
Wolter	Advanced Digital Signal Processing (S)	2
Wolter	Advanced Digital Signal Processing (L)	2

M1.6 Fundamentals of Machine Learning (FML)

Module leader:	Prof. Dr.-Ing. Mario Goldenbaum		
ECTS points:	6 ECTS	Workload (h):	180h
Type of module and position in the course of study:	Mandatory module taught in the 2. semester	Contact hours (h):	56h
Scope und frequency of teaching:	14 classes in winter term	Self-study (h):	124h
Type of module and position in other study programs or continuing education offers:	Mandatory module in the 2. semester of the study program <i>short form</i>		
<p>Learning outcomes: In this module the students learn the basics and tools of machine learning and statistical learning theory and apply these fundamentals to selected real-world problems. After successfully completing this module the students will be able to...</p> <p>Knowledge and understanding (extension, consolidation and understanding of knowledge)</p> <ul style="list-style-type: none"> ... explain the fundamental mathematical concepts, models, and results of machine learning; ... develop basic algorithmic solutions and apply them to given sample data. <p>Using, applying and generating knowledge (applying and transferring knowledge, Scientific innovation)</p> <ul style="list-style-type: none"> ... choose the right model architecture for a given learning problem and explain how it works; ... evaluate the performance and robustness of a created model and compare it to other models; ... understand the impact of the statistics of the data and the impact of model parameters; ... do hyperparameter tuning to optimize model architectures. <p>Communication and cooperation</p> <ul style="list-style-type: none"> ... work together as a team on chosen machine learning problems and develop algorithmic solutions; ... present theoretical concepts and practical results to others and discuss them on a scientific level. <p>Reflection of academic and professional identity</p> <ul style="list-style-type: none"> ... to independently advance their knowledge and problem-solving skills; ... adhere to standards of professional action and documentation. 			
<p>Course content:</p> <ul style="list-style-type: none"> Types of learning Basics of statistical learning theory Regression models Lagrangian duality and convex optimization Regularization and stability Classification: logistic regression, k nearest neighbors, SVMs, kernel methods, decision trees, neural networks Clustering: k-means, spectral clustering Feature selection and dimensionality reduction 			
Language of teaching:	English		
Prerequisites:	None		
Preparation/literature:	<p>S. Shalev-Schwartz, S. Ben-David (2014): <i>Understanding Machine Learning – From Theory to Algorithms</i>, Cambridge University Press</p> <p>T. Hastie, R. Tibshirani, J. Friedman (2009): <i>The Elements of Statistical Learning – Data Mining, Inference, and Prediction</i>, 2nd Edition, Springer</p> <p>B. Schölkopf, A. J. Smola (2002): <i>Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond</i>, MIT Press</p> <p>C. M. Bishop (2006): <i>Pattern Recognition and Machine Learning</i>, Springer</p>		

Further information:	-			
Courses of the module				
Course title	Teaching staff	Contact hours per week	Learning and teaching methods	Examination method(s), scope and duration
Fundamentals of Machine Learning (S)	Mario Goldenbaum	2	Seminar	Oral examination (30 min) or written work under supervision (90 min) [60%] and scientific experimental work [40%]
Fundamentals of Machine Learning (L)	Mario Goldenbaum	2	Exp. lab work	
Bachelor programs only: Module-related tutorial				

1.8 Optical Communications (OCO)

Module code	1.7
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Semester	Winter semester
Module coordinator	Prof. Dr. rer.nat. Carsten Reinhardt
Qualification objectives	<p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • distinguish between different fiber types regarding attenuation, dispersion and interconnection techniques • determine parameters of using LED or LD in optical transmitters and PIN or APD in optical receivers • integrate components into a system considering power, spectrum and modulation of sources and mutual interaction between laser and fiber regarding optical feedback into lasers and interaction of spectrum and dispersion of fiber • evaluate quality of a transmission line by measuring receiver sensitivity, bit error ratio and eye pattern • design transmission systems with direct detection, WDM, optical amplifier and coherent detection • do project work in an international team of engineers with different scientific background (Optics, Electronics, Transmission, Testing, Networking)
Syllabus	<p>This module conveys systematic skills to design and apply fiber optic transmission systems and sensor systems.</p> <ul style="list-style-type: none"> • Introduction to fiber optic systems • Economic significance of photonics • Optical fibers, SM, MM, POF (<i>optical transmission line</i>) • Optical sources, LED, LD (<i>optical transmitter</i>) • Photodiodes, PIN, APD (<i>optical receiver</i>) • Optical interconnection, Splicing (<i>covered by lab work</i>) • Optical Systems and Networks (<i>including lab work</i>)
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work

Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list

Agrawal, *Lightwave Technology*, Vol. 1,2, Wiley Interscience
 Keiser, *Optical Fiber Communications*, McGraw-Hill Intern.
 Derickson, *Fiber Optic Test and Measurement*, Prentice Hall
 Senior, *Optical Fiber Communications*, Prentice Hall
 Voges, Petermann, *Optische Kommunikationstechnik*, Springer

Courses		
Lecturer	Title of the course	Hours per week and semester
Reinhardt	Optical Communications (S)	2
Wenke	Optical Communications (L)	2

1.9 Satellite Communications (SCO)

Module code	1.8
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Semester	Winter semester
Module coordinator	Prof. Dr. Sören Peik
Qualification objectives	<p>The module provides a comprehensive introduction to satellite communications and a thorough grounding in the design issues of orbit selection, link design, and signal processing. Throughout the term references to and discussions of today's satellite systems are included.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • describe the orbital movement of satellites • compute the satellite location in space and with respect to a ground station • evaluate the extraordinary design goals for a space environment • set up a link budget • assess the risks and hazards of space flight • apply engineering project management to space flight applications • do project work in an international team
Syllabus	<ul style="list-style-type: none"> • Introduction • Orbital Mechanics • Satellite Launch Systems • The Space Segment • The Ground Segment • Space System Project Management • Space System Engineering • The Communication Link • Satellite Based Navigation
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions

Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list	<p>Maral, Bousquet, <i>Satellite Communication Systems</i>, Wiley Books</p> <p>M. Richharia, <i>Satellite Communication Systems and Design Principles</i>, MacMillan</p> <p>Larson & Wertz, <i>Space Mission Analysis and Design</i></p> <p>M. Richharia, <i>Satellite Communication Systems</i>, MacMillan</p> <p>B. Sklar, <i>Digital Communications</i>, Prentice Hall</p> <p>W. Mansfeld, <i>Satellitenortung und Navigation</i>, Vieweg</p>
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Courses		
Lecturer	Title of the course	Hours per week and semester
Peik	Satellite Communications (S)	2
Peik	Satellite Communications (L)	2

1.10 Image Processing and Pattern Recognition (IPPR)

Module code	1.9
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Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	<p>The objective of this module is to introduce the students into the basic principles of image processing methods and their discretization, the necessary processing steps for pattern recognition as well as the evaluation of developed algorithms for automatic target recognition systems. All principles are introduced for a wide range of different applications, like 2D-, 3D-, grayscale-, coloured-, multispectral-images or videos.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • understand the basic concepts of image processing and pattern recognition • determine and interpret properties of digital images and their natures • extend the system theoretic concepts for imaging systems • specify appropriate filtering and segmentation approaches for noisy images and videos • distinguish between area-based and contour-based approaches for representing objects of interest • select suitable methods to reduce redundant information and to select appropriate object features • design classifiers for object recognition • establish an understanding for limitations of different methods depending on the application • investigate and assess the aforementioned topics using Matlab
Syllabus	<ul style="list-style-type: none"> • Image Processing <ul style="list-style-type: none"> - Introduction to image processing - System theoretic concepts of imaging systems - Pixel processing and neighbourhood processing - Image segmentation and shape representation • Pattern Recognition <ul style="list-style-type: none"> - Introduction to pattern recognition - Feature selection techniques - Classifier concepts • Automatic target recognition systems
Type of module	Compulsory optional module in MSE, MAI and CSE

Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>B. Lehmann, <i>Image Processing and Pattern Recognition</i>, lecture notes, Hochschule Bremen</p> <p>T. Hastie, et al., <i>The Elements of Statistical Learning: Data Mining, Inference and Prediction</i>, Springer, 2017</p> <p>B. Jähne, <i>Digital Image Processing: Concepts, Algorithms and Scientific Applications</i>, Springer, 2005</p> <p>C.M. Bishop, <i>Pattern Recognition and Machine Learning</i>, Springer, 2007</p> <p>S. Theodoridis et al., <i>Introduction to Pattern Recognition - A MATLAB Approach</i>, Academic Press, 2010</p>

Courses		
Lecturer	Title of the course	Hours per week and semester
Lehmann	Image Processing and Pattern Recognition (S)	2

Lehmann	Image Processing and Pattern Recognition (L)	2
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1.11 Electronics Engineering Project (EEP)

Module code	1.10 und 2.10
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Semester	Winter semester / summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	<p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • identify and describe relevant project parameters like key engineering components, design tools and measurement equipment • evaluate and structure a given project topic on electronics engineering regarding scheduling, monitoring and control • do self-directed studies within running research projects on electronics engineering under guidance of project manager • acquire knowledge and skills on given engineering topics by applying learning by doing • work effectively in a team, present scientific results on investigations, design and measurements and improve the outcome of group meetings and discussions
Syllabus	<ul style="list-style-type: none"> • Introduction into EEP: Subjects are related to Electronics Engineering course and are usually coming from current research projects in institutes i3m, IWSS and IAT. • Methods on scientific investigations in electronics engineering using literature and internet support • Team work • Project implementation, scheduling, monitoring and control • Function, performance and application of project relevant engineering components, design tools and measurement equipment within a defined research project on optics, electronics, microsystems, communications, measurement and instrumentation • Methods on evaluation of results, documentation and presentation techniques
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Seminars on project monitoring and guidance (S)
Assessment	Written project report and oral project presentation with subsequent discussion

Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	References are announced at the beginning of the project.

Courses		
Lecturer	Title of the course	Hours per week and semester
Fleischmann , Goldenbaum , Henning, Kempen, Kraus, Meiners, Peik, Reinhardt, Wolter	Electronics Engineering Project (S)	4

1.12 Advanced Hardware Verification (AHV)

Module code	2.1 in MSE
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Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Stefan Wolter
Qualification objectives	<p>Driven by the evolving FPGA technology, design and verification tools become more powerful and complex. To address this, the module covers high-level design tools and verification techniques. The module focuses on Functional Verification using SystemVerilog Assertions and DSP hardware design from algorithm to hardware using the Xilinx DSP System Generator.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • write SystemVerilog assertions, bind them to design objects and analyze them with ModelSim/Questa • develop DSP hardware architectures using Xilinx DSP System Generator
Syllabus	<ul style="list-style-type: none"> • Assertion Based Verification Methodology • SystemVerilog Assertions • ABV with ModelSim/Questa • DSP hardware design using Xilinx DSP System Generator
Type of module	Core module in MSE, compulsory optional module in MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60

Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list	<p>Vijaraghavan / Ramanathan, <i>A Practical Guide for SystemVerilog Assertions</i>, Springer</p> <p>Cerny / Dudani / Havlicek / Korechmny, <i>The Power of Assertions in SystemVerilog</i>, Springer</p> <p>Cohen / Venkataramanan / Kumari, <i>SystemVerilog Assertions Handbook</i>, vhdcohen Publishing</p> <p>Xilinx System Generator for DSP and Xilinx ISE, http://www.xilinx.com</p>
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Courses		
Lecturer	Title of the course	Hours per week and semester
Wolter	Advanced Hardware Verification (S)	2
Wolter	Advanced Hardware Verification (L)	2

1.13 Micro-Technology and Micro-Systems (MTS)

Module code	2.2 in MSE
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Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Ludger Kempen
Qualification objectives	<p>This module provides knowledge about typical production processes of silicon micro-technology. Physical principles and design of different microsystems are discussed. Students present research results on microsystems from recent published papers.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • understand the typical micro-structuring process flow and the influence of different process parameters • select an optimal production process depending on the specific needs of individual microsystems • understand the theory of operation of different microsystems • design microsystems for specific applications • work with publications from research journals • present research results in an oral presentation
Syllabus	<ul style="list-style-type: none"> • Process flow of silicon micro-technology including film deposition, lithography, etching, doping, wafer bonding and packaging • Theory of current microsystem devices like inertial sensors, membrane applications, microfluidics, optical microsystems, etc. • Examples of recent research results on microsystems
Type of module	Core module in MSE, compulsory optional module in MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	

Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	S. Franssila, <i>Introduction to Microfabrication</i> , Wiley, 2010

Courses		
Lecturer	Title of the course	Hours per week and semester
Kempen	Micro-Technology and Micro-Systems (S)	2
Kempen	Micro-Technology and Micro-Systems (L)	2

1.14 Computer Aided Data Acquisition (CADA)

Module code	2.1 in MAI
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Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Friedrich Fleischmann
Qualification objectives	<p>Students are able to use different types of test circuits and acquisition hardware as well as interfaces and instrumentation buses. They will be able to select hardware, bus systems and control language according to the needs of the measuring task. They can design and apply automated test systems, evaluate results and document the setup.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • distinguish between actual tools in measurement • automation regarding overhead, latency, maintainability • assess decisive characteristics of acquisition hardware • integrate components into a system considering mutual interaction and influence • apply systemic thinking in systems design including heterogeneous system components and topologie • do project work in a team • decide autonomous about organisation and conduct of experiments • assess results from experiment, evaluate in team and document scientifically
Syllabus	<ul style="list-style-type: none"> • Introduction to acquisition hardware • Introduction to software tools • Interfaces and bus systems
Type of module	Core module in MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.

Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list	<p>R. Lerch, <i>Elektrische Messtechnik</i>, Springer</p> <p>A.V. Oppenheim, R.W. Schafer: <i>Digital Signal Processing</i>, Prentice-Hall</p> <p>A.V. Oppenheim, <i>Applications of Digital Signal Processing</i>, Prentice-Hall</p> <p>R.W. Hamming, <i>Digitale Filter</i>, VCH-Wiley</p> <p>N. Hesselman, <i>Digitale Signalverarbeitung</i>, Vogel</p> <p>P. Addison, <i>The illustrated wavelet transform handbook</i>, IOP</p> <p>R. Jamal, A. Hagestedt: <i>Das Labview-Grundlagenbuch</i></p> <p>R.B. Angus, T.E. Hulbert: <i>VEE Pro: Practical graphical programming</i>, Springer</p> <p><i>Agilent VEE - Practical Graphical Programming</i>, Agilent</p>
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Courses		
Lecturer	Title of the course	Hours per week and semester
Fleischman n	Computer Aided Data Acquisition (S)	24
Fleischman n	Computer Aided Data Acquisition (L)	24

1.15 Fiber Optic Test and Measurement (FOTM)

Module code	2.2 in MAI
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Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Carsten Reinhardt
Qualification objectives	<p>The student can operate optical and electronic measurement equipment in the areas of power, polarization and spectral analysis and is able to understand the interactions of components in a fiber-optic system by systematic test and measurement.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • select suitable detector types like thermal detectors and photodetectors and to measure quantum efficiency, responsivity, insertion loss and polarization dependent and wavelength dependent loss. • describe and measure state of polarization, degree of polarization, polarization ellipse, Stokes parameter, Poincare sphere, birefringence in crystals, optical activity and state of polarization in optical fibers. • use wavelength filters, blazed diffraction gratings in transmission and reflection and calculate resolving power. • determine parameters of Fabry-Perot-interferometer like free spectral range, finesse and resolution. • distinguish between Fresnel- and Fraunhofer diffraction, apply diffraction for measurement of diameter and ovality of optical fibers and wires) • do project work in an international team of engineers with different scientific background (Optics, Electronics, Transmission, Testing, Networking)
Syllabus	<ul style="list-style-type: none"> • Introduction to fiber optic test and measurement • Optical power measurement • Polarization measurement • Spectral Analysis • Diffraction of Light and Measurement Applications
Type of module	Core module in MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)

Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>D. Derickson, <i>Fiber optic Test and Measurement</i>, Prentice Hall</p> <p>F.L. Pedrotti et al., <i>Introduction to Optics</i>, Prentice Hall</p> <p>G.P. Agrawal, <i>Fiber-Optic Communication Systems</i>, Wiley Interscience</p> <p>G. Keiser, <i>Optical Fiber Communications</i>, McGraw-Hill Intern.</p> <p>W. Daum et al., <i>Polymer Optical Fibers for Data Communication</i>, Springer</p> <p>E. Voges, K. Petermann, <i>Optische Kommunikationstechnik</i>, Springer</p>

Courses		
Lecturer	Title of the course	Hours per week and semester
Reinhardt	Fiber Optic Test and Measurement (S)	2
Reinhardt	Fiber Optic Test and Measurement (L)	2

M1.16 Information and Coding Theory (ICT)

Module leader:	Prof. Dr.-Ing. Mario Goldenbaum		
ECTS points:	6 ECTS	Workload (h):	180h
Type of module and position in the course of study:	Mandatory module taught in the 2. semester	Contact hours (h):	56h
Scope und frequency of teaching:	14 classes in winter term	Self-study (h):	124h
Type of module and position in other study programs or continuing education offers:	Mandatory module in the 2. semester of the study program <i>short form</i>		
<p>Learning outcomes: In this module the students learn the basic concepts, tools, and results of single-user information theory as well as the fundamentals of algebraic coding theory and apply them to data compression and data transmission problems. After successfully completing this module the students will be able to...</p> <p>Knowledge and understanding (extension, consolidation and understanding of knowledge)</p> <ul style="list-style-type: none"> • ... describe and quantify information; • ... explain the fundamental limits of data compression and data transmission; • ... understand basic algebraic coding schemes used in digital communication systems. <p>Using, applying and generating knowledge (applying and transferring knowledge, Scientific innovation)</p> <ul style="list-style-type: none"> • ... compute the fundamental limits of data sources and communication channels; • ... evaluate the performance and robustness of point-to-point communication systems; • ... choose and implement coding schemes that fulfill given system requirements; <p>Communication and cooperation</p> <ul style="list-style-type: none"> • ... work together as a team on chosen information theoretic problems and develop algorithmic solutions; • ... present theoretical concepts and practical results to others and discuss them on a scientific level. <p>Reflection of academic and professional identity</p> <ul style="list-style-type: none"> • ... to independently advance their knowledge and problem-solving abilities; • ... adhere to standards of professional action and documentation. 			
<p>Course content:</p> <ul style="list-style-type: none"> • Information measures • Data compression • Channel capacity • Differential entropy and Gaussian channels • Introduction to algebra • Linear and cyclic codes • Codes and polynomials • Error probability bounds • Decoding methods • Turbo and LDPC codes 			
Language of teaching:	English		
Prerequisites:	None		
Preparation/literature:	<p>T. M. Cover, J. A. Thomas (2006): <i>Elements of Information Theory</i>, 2nd Edition, John Wiley & Sons</p> <p>R. G. Gallager (1968): <i>Information Theory and Reliable Communication</i>, John Wiley & Sons</p> <p>R. E. Blahut (2008): <i>Algebraic Codes for Data Transmission</i>, Cambridge University</p>		

	Press S. Lin, D. J. Costello (2004): <i>Error Control Coding</i> , Prentice Hall			
Further information:	-			
Courses of the module				
Course title	Teaching staff	Contact hours per week	Learning and teaching methods	Examination method(s), scope and duration
Fundamentals of Machine Learning (S)	Mario Goldenbaum	2	Seminar	Oral examination (30 min) or written work under supervision (90 min) [60%] and scientific experimental work [40%]
Fundamentals of Machine Learning (L)	Mario Goldenbaum	2	Exp. lab work	
Bachelor programs only: Module-related tutorial				

1.17 Microwave Circuits and Systems (MCS)

Module code	2.2 in CSE
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Semester	Summer semester
Module coordinator	Prof. Dr. Sören Peik
Qualification objectives	<p>The aim of this module is to gain an understanding of today's design process of active and passive microwave circuits. Secondly, the module provides an overview of typical microwave circuit applications for modern wireless communication systems.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • explain the wave propagation in free space and on lines • design simple microwave power divider and coupler • evaluate the noise performance of microwave systems • design a low noise microwave amplifier in a team • explain the basic operation of microwave systems like receivers, transmitters, radars etc.
Syllabus	<ul style="list-style-type: none"> • Introduction • Repetition of Wave Theory • Microwave Network Analysis • Impedance Matching and Tuning • Microwave Passive Structures • Noise in Two-Ports • Microwave Amplifier Design • Mixer and Oscillator • Microwave Systems
Type of module	Core module in CSE, compulsory optional module in MSE and MAI
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	

Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list	<p>D. M. Pozar, <i>Microwave and RF Design of Wireless Systems</i>, Addison-Wesley, 2002</p> <p>R. Ludwig, P. Bretchko, <i>RF Circuit Design</i>, Prentice Hall, 2000</p> <p>R. E. Collin, <i>Foundations For Microwave Engineering</i>, McGraw-Hill, 1992</p> <p>G. Gonzalez, <i>Microwave Transistor Amplifiers</i>, Prentice Hall, 1997</p> <p>P. Abrie, <i>Design of RF and Microwave Amplifiers and Oscillators</i>, Artech House, 2000</p> <p>G. Maral, M. Bousquet, <i>Satellite Communication Systems: Systems, Techniques and Technology</i>, Wiley Books, 1998</p>
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Courses		
Lecturer	Title of the course	Hours per week and semester
Peik	Microwave Circuits and Systems (S)	2
Peik	Microwave Circuits and Systems (L)	2

1.18 Advanced Topics of Lasers (ATL)

Module code	2.6
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Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Thomas Henning
Qualification objectives	<p>This module conveys systematic skills to design and apply laser systems.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • distinguish between different types of laser systems and typical laser applications in fields of medicine, metrology and material processing • determine laser systems for specific applications • integrate components into a laser system • evaluate quality of a laser system with respect to a given application • design optical beam shaping systems for adjusting laser radiation to a specific application • do project work in an international team of engineers with different scientific background (Optics, Electronics, Materials, Communications, Metrology)
Syllabus	<ul style="list-style-type: none"> • Typical laser applications: laser cleaning, rapid prototyping, medical applications, laser annealing • Characterization of laser radiation • Development of beam delivery and beam shaping systems • Application of short pulse laser systems • Generation of short pulses • Laser micro processing • Optical metrology and spectroscopy
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions

Usability

Student workload 60 + 120

Contact hours 60

Independent study 120

ECTS points 6

Duration and frequency Once per study year / 15 Terms

Language English

Reading list
 A.E. Siegman, *Lasers*, University Science Book
 O. Svelto, *Principles of Lasers*, Plenum Press
 M. Young, *Optics and Lasers*, Springer
 J. Eichler, H.J. Eichler, *Laser*, Springer

Courses		
Lecturer	Title of the course	Hours per week and semester
Henning	Advanced Topics of Lasers (S)	2
Henning	Advanced Topics of Lasers (L)	2

1.19 Underwater Acoustics and Sonar Signal Processing (USP)

Module code	2.7
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Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	<p>This module conveys a comprehensive knowledge and understanding about underwater acoustics and sonar systems.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • evaluate Sound Velocity, Typical Sound Velocity Profiles, Transmission Loss of Sound, Sound Reflection/Transmission at Interfaces, Sound Scattering, Ambient Noise, Sonar Performance Prediction • perform modeling of sound propagation using Wave Equation, Homogeneous Waveguide (Image Source and Normal Mode Approach), Inhomogeneous Waveguide (Ray Tracing) • design sonar antennas having Continuous/Discrete Apertures of Linear, Rectangular and Circular Shape, evaluate Array Gain and Directivity Index • process sonar signals considering Signal Processing Chain, Quadrature Demodulation, Matched Filtering, Range Resolution, Doppler Effect, Pulse Compression and Signal Detection • apply array signal processing methods with Conventional Beamforming (Time / Frequency Domain), High Resolution Methods (MVDR Beamformer, MUSIC Algorithm and Maximum Likelihood DOA Estimation)
Syllabus	<ul style="list-style-type: none"> • Fundamentals of Ocean Acoustics • Sound Propagation Modeling • Sonar Antenna Design • Sonar Signal Processing • Array Processing
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work

Pre-requisites	No specific pre-conditions
Usability	
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list

D. Kraus, *Underwater Acoustics and Sonar Signal Processing*, lecture notes Hochschule Bremen

L.M. Brekhovskikh, Y.P. Lysanov, *Fundamentals of Ocean Acoustics*, Springer, 2001

W.S. Burdic, *Underwater Acoustic System Analysis*, Prentice Hall, 1991.

F. B. Jensen et al., *Computational Ocean Acoustics*, Springer, 2011

X. Lurton, *An Introduction to Underwater Acoustics: Principles and Applications*, Springer, 2010

H. L. van Trees, *Optimum Array Processing*, Part 4 of Detection, Estimation and Modulation Theory, Wiley, 2002

Courses		
Lecturer	Title of the course	Hours per week and semester
Kraus	Underwater Acoustics and Sonar Signal Processing (S)	2
Kraus	Underwater Acoustics and Sonar Signal Processing (L)	2

1.20 Wireless Communications (WCO)

Module code	2.8
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Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Mario Goldenbaum
Qualification objectives	<p>Starting from the physical free space path the course develops an understanding of today's digital wireless communications techniques.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • explain the effects of free space wave propagation • distinguish between the various modulation techniques and multiple access techniques • decide for the optimal coding and modulation technique for given constraints • evaluate the quality of service of a digital wireless link • explain the basic operation principle of the most popular wireless systems like GSM, UMTS, LTE, and LTE-Advanced as well as WLAN, Bluetooth etc.
Syllabus	<ul style="list-style-type: none"> • Introduction to wireless communication • Wireless Transmission • Cellular System Design Fundamentals • Propagation, Fading, Multipath • Modulation Techniques • Multiple Access Techniques • Equalization, Diversity • Cellular Systems (GSM, UMTS, LTE, LTE-Advanced) • Short Range Communication Systems (BT, WLAN) • Economical Aspects
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.

Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English

Reading list	<p>T. Rappaport, <i>Wireless Communications: Principles and Practice</i>, Prentice Hall, 2002</p> <p>J. Schiller, <i>Mobile Communications</i>, Pearson, 2003</p> <p>D.N.C. Tse, P. Viswanath, <i>Fundamentals of Wireless Communication</i>, Cambridge University Press, 2005</p>
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Courses		
Lecturer	Title of the course	Hours per week and semester
Goldenbaum	Wireless Communications (S)	2
Goldenbaum	Wireless Communications (L)	2

1.21 Analogue and Mixed-Signal Circuit Design (AMCD)

Module code	2.9
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Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Mirco Meiners
Qualification objectives	<p>The students possess a thorough understanding of the basic principles, challenges and limitations in analogue and mixed-signal circuit design with</p> <ul style="list-style-type: none"> • focus on concepts that are unlikely to expire and • preparation for further study of state-of-the-art "fine-tuned" realizations <p>After completion of this module the students have acquired</p> <ul style="list-style-type: none"> • basic intuition by studying a selection of commonly used circuit and design techniques • depth through a design project that entails design, optimization and thorough characterization of dedicated circuit in modern technology
Syllabus	<ul style="list-style-type: none"> • Continuous time and switched-capacitor filters • Design of integrators (OTAs) and auxiliary circuits • Analog-to-Digital Converters
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars (S) and Experimental Laboratory Work (L)
Assessment	Oral examination (30 min) or written work under supervision (90 min) and scientific experimental work
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc.
Student workload	60 + 120
Contact hours	60

Independent study	120
ECTS points	6
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	A concurrent reference list will be offered in the beginning of the course on AULIS.

Courses		
Lecturer	Title of the course	Hours per week and semester
Meiners	Analogue and Mixed-Signal Circuit Design (S)	2
Meiners	Analogue and Mixed-Signal Circuit Design (L)	2

1.22 Organisational Behaviour (ORB)

Module code	1.11 und 2.11
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Semester	Winter semester ORB I - Unit 1 Summer semester ORB II - Unit 2
Module coordinator	Dipl.-Ing., Dipl.-Oec. Birgit Zich
Qualification objectives	<p>Managers generally appreciate how important it is to understand the workings of the economy and the industries in which they are employed. But no less important are the people that comprise a firm. Understanding what motivates people at work are essential skills for managers at all levels in an organisation.</p> <p>In the twenty-first century, the environment in which organisations operate is increasingly turbulent, rocked by forces such as globalisation and rapid technological change. Social and demographic forces have dramatically changed the make-up of today's workforce which is now the most educated and ethnically diverse in history, in addition to having the greatest representation of women. These developments are profoundly affecting the way in which organisations structure themselves, just as they are influencing individuals' attitudes to and expectations of both organisations and work.</p> <p>After completion of the course the students will be able to</p> <ul style="list-style-type: none"> • understand the workings of the economy and the industries in which they are employed • understand what motivates people at work and what causes people to behave as they do • have an understanding for diversity and change management • understand the importance of communication in intercultural groups • practise techniques designed to develop effectiveness both personally and in team roles
Syllabus	<p>The impact of organisational structure on individual and organisational effectiveness; leadership; conflict management; decision-making; motivation and stress.</p> <p>UNIT 1 and UNIT 2 are independent modules.</p> <p>UNIT 1 - The Individual</p> <ul style="list-style-type: none"> • Introduction - What Is Organisational Behaviour? • Foundations of Individual Behaviour • Perception and Individual Decision Making • Values, Attitudes, and Job Satisfaction • Basic Motivation Concepts • Motivation: From Concepts to Applications <p>UNIT 2 - The Group</p> <ul style="list-style-type: none"> • Foundations of Group Behaviour • Understanding Work Teams • Communication • Leadership • Power and Politics

	<ul style="list-style-type: none"> • Conflict, Negotiation, and Intergroup Behaviour
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Project Work and Tuition in Seminars
Assessment	Written project report and oral project presentation with subsequent discussion
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc., ZES M.Eng.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6 (for ORB I & ORB II)
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>R. Kreitner, A. Kinicki, <i>Organizational Behavior: Key Concepts, Skills & Best Practices</i>, McGraw Hill, 2012</p> <p>J. Mattock, <i>Cross-Cultural Communication: The Essential Guide to International Business</i>, Kogan Page, 2003</p> <p>S.P. Robbins, T.A. Judge, <i>Organizational Behavior</i>, Prentice Hall, 2016</p>

Courses		
Lecturer	Title of the course	Hours per week and semester
Zich	ORB I (Organisational Behaviour I)	2
Zich	ORB I (Organisational Behaviour II)	2

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1.23 Project Management and Teambuilding (PMT)

Module code	1.12 und 2.12
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Semester	Winter semester PMT I - Teambuilding Summer semester PMT II - Project Management
Module coordinator	Dipl.-Ing., Dipl.-Oec. Birgit Zich
Qualification objectives	<p>This module conveys systematic skills to design projects including the aspects of teambuilding. Students will be able on entering the workforce to manage several projects at the same time with given, often limited, resources. They will use project management as a standard work-skill and as a powerful tool to assist in the management of very large projects to bring the project in on time, within budget and to the satisfaction of the client.</p> <p>After completion of the PMT I Unit the students are able to</p> <ul style="list-style-type: none"> • feel more comfortable in group situations • develop and use 'leadership' and listening skills • understand the importance of communication in group situations • be aware of their own 'team profile' and those of other team members • practise techniques designed to develop effectiveness both personally and in team roles • use techniques to improve the outcome of group meetings and discussions <p>After completion of the PMT II Unit the students are able to</p> <ul style="list-style-type: none"> • select and evaluate a project including definition of life cycle and the role of a project manager • implement and organise a project regarding scheduling, monitoring and control • handle budgeting and costing • apply tools PERT, CPM and Gantt Charts in scheduling • Successfully complete case studies regarding topics from electronics engineering using Microsoft Project® program
Syllabus	<ul style="list-style-type: none"> • PMT I / Team Building is basically divided in three main parts <ul style="list-style-type: none"> - Self-perception and Belbin's Profile - Team work - 7 Habits of effective people (covey) and team learning • PMT II / Project Management addresses <ul style="list-style-type: none"> - What constitutes a PROJECT? - Project selection and evaluation - The project life cycle - The project manager - Organisation and planning - Project implementation; scheduling, monitoring and

	<ul style="list-style-type: none"> control - Budgeting and costing - Scheduling tools such as PERT, CPM and Gantt Charts - Successful completion - Use will be made of the Microsoft Project® program - Case studies to demonstrate aspects of the topics covered
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Project Work and Tuition in Seminars
Assessment	Written project report and oral project presentation with subsequent discussion
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc., ZES M.Eng.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6 (for PMT I & PMT II)
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	<p>C. Gray, E. Larson, <i>Project Management: The Managerial Process</i>, McGraw Hill, 2017</p> <p>J. Meredith, S. Mantel, S., <i>Project Management: A Managerial Approach</i>, Wiley, 2015</p>

Courses		
Lecturer	Title of the course	Hours per week and semester

Zich	PMT I (Teambuilding)	2
Zich	PMT II (Project Management)	2

1.24 Operations Management (OPM)

Module code	1.13 und 2.13
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Semester	Winter semester OPM I - Unit 1 Summer semester OPM II - Unit 2
Module coordinator	Dipl.-Ing., Dipl.-Oec. Birgit Zich
Qualification objectives	Operations management is concerned with managing processes, and how organizations create value in the production of goods and services. This field of study is applicable in manufacturing and the service sector, from small retailers and professionals to banks and insurance companies, hospitals and utilities. We study how firms achieve competitive success through improving the processes involved in delivering products and services, and reducing costs through increased efficiencies. The module covers operations strategy, process design, planning and control, quality, supply chain management, and improving how the product/service is delivered.
Syllabus	<p>UNIT 1 and UNIT 2 are independent modules.</p> <p>UNIT 1 The Strategy of Productive Systems</p> <ul style="list-style-type: none"> • Introduction to Operations and Competitiveness • Operations Strategy • Quality Management • Statistical Quality Control <p>Designing Productive Systems</p> <ul style="list-style-type: none"> • Product and Service Design • Process Planning, Analysis, and Reengineering • Facility Layout • Human Resources in Operations Management • Supply Chain Management <p>UNIT 2 Operating Productive Systems</p> <ul style="list-style-type: none"> • Forecasting • Capacity Planning and Aggregate Production Planning • Inventory Management • Material Requirements Planning • Scheduling • Just-in-Time Systems • Waiting Line Models for Service Improvement
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Project Work and Tuition in Seminars

Assessment	Written project report and oral project presentation with subsequent discussion
Pre-requisites	No specific pre-conditions
Usability	Informatik M.Sc., ZES M.Eng.
Student workload	60 + 120
Contact hours	60
Independent study	120
ECTS points	6 (for OPM I & OPM II)
Duration and frequency	Once per study year / 15 Terms
Language	English
Reading list	N. Slack, A. Brandon-Jones and R. Johnston, <i>Operations Management</i> , Pearson, 2016 R.S. Russell, B. W. Taylor, I. Castillo and N. Vidyarthi, <i>Operations Management: Creating Value Along the Supply Chain</i> , Wiley, 2016

Courses		
Lecturer	Title of the course	Hours per week and semester
Zich	OPM I (Operations Management)	2
Zich	OPM II (Operations Management)	2

1.25 Language Module German (LMG)

Module code	1.14 und 2.14
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Semester	Winter semester / summer semester
Module coordinator	Dipl.-Oec. Birgit Zich
Qualification objectives	<p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • understand the main ideas of complex German texts on both concrete and abstract topics, including technical discussions in his/her field of specialization • interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strains for either party • produce clear, detailed text in German on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
Syllabus	<p>Contents are defined by the institution offering German language classes according to above given qualification objectives</p> <ul style="list-style-type: none"> • Fremdsprachenzentrum des Landes Bremen
Type of module	Compulsory optional module in MSE, MAI and CSE
Teaching and learning methods	Tuition in Seminars
Assessment	Oral examination (30 min) or written work under supervision (90 min)
Pre-requisites	No specific pre-conditions
Usability	
Student workload	60 + 120
Contact hours	60

Independent study 120

ECTS points 6

Duration and frequency Once per study year / 15 Terms

Language

Reading list

Courses		
Lecturer	Title of the course	Hours per week and semester
FZHB	Language Module German	4

1.15 Research Methods I (RM1)

Module leader:	Prof. Dr.-Ing. Friedrich Fleischmann		
ECTS points:	3 ECTS	Workload (h):	90
Type of module and position in the course of study:	Elective module taught in the 1. semester	Contact hours (h):	28
Scope und frequency of teaching:	14 classes in winter term	Self-study (h):	62
Type of module and position in other study programs or continuing education offers:	Elective module in the 1. semester of the study program <i>short form</i>		

Learning outcomes:

Knowledge and understanding (extension, consolidation and understanding of knowledge)

- penetrate a relevant section of a given subject area with regard to relevant questions and discussions of the scientific community,
- formulate their own scientific question,
- carry out scientific research,
- correctly summarize the state of the art in science and technology, establish essential references to the previously defined question and present own findings and conclusions.

Using, applying and generating knowledge (applying and transferring knowledge, Scientific innovation)

- correctly transfer the acquired knowledge (theory / findings) to further examples or application domains,
- are able to search for relevant information for decision-making on the basis of an incomplete information base
- are able to draw scientifically sound conclusions or make decisions from this information.
- draw scientifically sound conclusions or make decisions, taking into account social and ethical findings.

Communication and cooperation

- present the findings to the whole group, discuss them and defend them against objections
- Critically reflect on the findings of others from a scientific perspective and give feedback
- Deal constructively with direct criticism of content

Reflection of academic and professional identity

- adhere to standards of professional action and documentation
- pursue their own and other people's learning and work objectives in a self-directed way.
- place technological approaches in a social context, discuss and evaluate them

Course content:

- Research and scientific work
- Research ethics and rules of good scientific practice
- Dealing with scientific literature, citation
- Planning and writing scientific essays
- Scientific lecturing, presentation and communication

Language of teaching:	English
Prerequisites:	None
Preparation/literature:	Students will receive a reading list at the beginning of the semester.
Further information:	E.g. link to Aulis, if applicable

Courses of the module

Course title	Teaching staff	Contact hours per	Learning and teaching	Examination method(s), scope
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		week	methods	and duration
Research Methods I (S)	Fleischmann	1	Seminar	Presentation (30 min) and research essay (60%).
Research Methods I (P)	Müller	1	Project work	
Bachelor programs only: Module-related tutorial				

2.15 Research Methods II (RM2)

Module leader:	Prof. Dr.-Ing. Friedrich Fleischmann		
ECTS points:	3 ECTS	Workload (h):	90
Type of module and position in the course of study:	Elective module taught in the 2. semester	Contact hours (h):	28
Scope und frequency of teaching:	14 classes in winter term	Self-study (h):	62
Type of module and position in other study programs or continuing education offers:	Elective module in the 2. semester of the study program <i>short form</i>		
<p>Learning outcomes:</p> <p>Knowledge and understanding (extension, consolidation and understanding of knowledge)</p> <ul style="list-style-type: none"> • formulate their own scientific question • correctly summarize the state of the art in science and technology, establish essential references to the previously defined question and present own findings and conclusions • are familiar with patent research and patent application <p>Using, applying and generating knowledge (applying and transferring knowledge, Scientific innovation)</p> <ul style="list-style-type: none"> • are able to search for relevant information for decision-making on the basis of an incomplete information base • apply tools PERT, CPM and Gantt Charts in scheduling • organize a project regarding scheduling, monitoring and control <p>Communication and cooperation</p> <ul style="list-style-type: none"> • present the findings to the whole group, discuss them and defend them against objections • critically reflect on the findings of others from a scientific perspective and give feedback • write scientific publications and posters • phrase project proposals and patent applications <p>Reflection of academic and professional identity</p> <ul style="list-style-type: none"> • adhere to standards of professional action and documentation • place technological approaches in a social context, discuss and evaluate them 			
<p>Course content:</p> <ul style="list-style-type: none"> • Finding a topic and beginning the scientific work • Project and time management • Documentation and reporting • Scientific lecturing, scientific presentation and scientific communication • Texts for the public, graphic design and poster design • Project proposal and motivation letter • Patents • Entrepreneurship 			
Language of teaching:	English		
Prerequisites:	None		
Preparation/literature:	Students will receive a reading list at the beginning of the semester.		
Further information:	E.g. link to Aulis, if applicable		

Courses of the module

Course title	Teaching staff	Contact hours per	Learning and teaching	Examination method(s), scope
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		week	methods	and duration
Research Methods II (S)	Fleischmann	1	Seminar	Presentation (30 min) and research essay (60%).
Research Methods II (P)	Müller	1	Project work	
Bachelor programs only: Module-related tutorial				

1.26 Master Thesis (MTH)

Module code	3.1
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Semester	Winter semester / summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	<p>In thesis work, students have to show that they are able to treat a scientific or technical subject self-directed within a given period of time and to integrate it into a larger interdisciplinary context.</p> <p>The development / research task can be carried out in a university laboratory, in industry or at a partner institution in Germany or abroad, as desired.</p> <p>The written part should be completed in English (exceptions in German language have to be approved by the examination board).</p> <p>In a final colloquium the subject will be presented and discussed.</p> <p>After completion of this module the students are able to</p> <ul style="list-style-type: none"> • investigate scientific problems in a systematic way • find and use original literature • evaluate and describe solutions of scientific problems • apply time management in theoretical and experimental investigations • evaluate and write thesis work including use of references • work under supervision in a self-directed, autonomous way to complete Master Thesis • consider the role and responsibilities of an engineer in industry and society in their actions and outcomes
Syllabus	<p>Organised as block course of 4 hours duration at begin, regular, once per week, consultation during thesis work.</p> <ul style="list-style-type: none"> • Presentation of topic related to selected program • Scientific investigations, tools to find references • Organisation of work, time management • Presentation of results, written and in oral form, preparing colloquium
Type of module	Core Module in MSE, MAI and CSE
Teaching and learning	<p>Internal or external thesis work</p> <p>Study with full-time attendance and self-study</p> <p>Seminars for guidance and supervision (S)</p>

methods	
Assessment	Written part (Master Thesis) and colloquium (oral presentation and discussion) (45 min)
Pre-requisites	48 credit points of modules in first two semesters completed
Usability	
Student workload	60 + 840
Contact hours	60 in Seminar
Independent study	840
ECTS points	30
Duration and frequency	Six month / each semester
Language	English
Reading list	Literature depends on selected topic

Courses		
Lecturer	Title of the course	Hours per week and semester
Lecturers of MScEE	Master Thesis (S)	4