Akkreditierungsantrag

der

Hochschule Bremen

>>Electronics Engineering M.Sc. <<

„Teil E - Modulhandbuch“

Inhalt

1.1 Material Science (MSC)

Module code	1.1 in MSE

Semester	Winter semester
Module coordinator	Prof. Dr. rer.nat. Ludger Kempen
Qualification objectives	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 After completion of this course the students are able to • 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 • dimension of 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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, *Materials Science and Engineering: An Introduction*, 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

Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Mirco Meiners
Qualification objectives	The objective of this module is to introduce the students into the basic principles, challenges and limitations of concept engineering for mixed-technology systems. After completion of this module the students have acquired a thorough understanding of • Mixed-technology systems - Interfacing Systems on Chip (SoC) - Inertial systems, accelerometers, gyroscopes - Thermal or gaseous systems - Piezo systems • Design Methodology - Seamlessly modeling and design over all physical domains • Concept Engineering ASICs - Partitioning • Packaging
Syllabus	• 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 MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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

1.3 Measurement and Instrumentation (MIN)

Module code	1.1 in MAI

Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Friedrich Fleischmann
Qualification objectives	Students are able to apply different types of sensors, electronic test circuits, and sensor data conditioning. They can design measurement and test circuits, perform signal conditioning and processing and evaluate results and document the setup. Students are aware of the impact of mathematical basics of probability theory and statistics to hypothesis testing and quality control. They know principles of design of experiments and statistical process control and are able to use NIST-GUM. After completion of this module the students are able to • distinguish between different classes of sensors • assess decisive characteristics of acquisition hardware • develop signal acquisition circuits • apply systemic thinking in systems design including aspects of EMI control • apply statistical methods to evaluate significance of measurement results • do project work in a team • decide autonomous about organization and conduct of experiments • assess results from experiment, evaluate in team and document scientifically • present progress and results to supervisors and peers
Syllabus	• Sensor signal conditioning • Electronic circuits • Interfaces and bus systems • EMC/EMI in measurement applications • Hypothesis testing • Uncertainty in measurement • Design of experiments*)*
Type of module	Core module in MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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	R. Lerch, *Elektrische Messtechnik*, Springer A.V. Oppenheim, *Applications of Digital Signal Processing*, Prentice-Hall R.W. Hamming, *Digitale Filter*, VCH-Wiley N. Hesselmann, *Digitale Signalverarbeitung*, Vogel P. Addison, *The illustrated wavelet transform handbook*, IOP A. Papoulis, S.U. Pillai, *Probability, random variables and stochastic processes*, McGraw-Hill R. Tummala, *Microsystems Packaging*, McGraw-Hill *ISO Guide to the Expression of Uncertainty in Measurement* *NIST Technical Note 1297* *DIN ENV 13005*

Courses		
Lecturer	**Title of the course**	**Hours per week and semester**
Fleischmann	Measurement and Instrumentation (S)	2
Fleischmann	Measurement and Instrumentation (L)	2

1.4 Laser Systems and Applications (LSA)

Module code	1.2 in MAI

Semester	Winter semester
Module coordinator	Prof. Dr. rer.nat. Thomas Henning
Qualification objectives	This module conveys systematic skills to design and apply laser systems. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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

Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	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. After completion of this module the students are able to • 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. • extent 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	• 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 Coloured 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	Tuition in seminars (2 SWS),

methods	laboratory exercises and projects (2 SWS)
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	D. Kraus, *Stochastic Signals and Systems,* lecture notes chapter 1, 2 and 6, Hochschule Bremen J.F. Böhme, *Stochastische Signale: Eine Einführung in Modelle, Systemtheorie und Statistik mit Übungen und einem MATLAB-Praktikum*, Teubner, 1998 E. Hänsler, *Statistische Signale: Grundlagen und Anwendungen*, Springer, 2001 A. Papoulis, S.U. Pillai, *Probability, Random Variables and Stochastic Processes,* McGraw-Hill, 2001 S. Kay, *Intuitive Probability and Random Processes using MATLAB,* Springer, 2006

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

1.6 Advanced Digital Signal Processing (ADSP)

Module code	1.2 in CSE

Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Stefan Wolter
Qualification objectives	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 wordlength effects and multirate signal processing. A key feature of the module is the computer-assisted learning approach using MATLAB and Simulink. After completion of this module the students are able to • 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	• computation of the Discrete Fourier Transform • spectral analysis of signals • finite wordlength 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 (2 SWS), laboratory exercises and projects (2 SWS)
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	Mitra, Digital Signal Processing, McGraw-Hill International Editions Proakis/Manolakis, Digital Signal Processing, Pearson International Edition Kammeyer/Kroschel, Digitale Signalverarbeitung, Vieweg+Teubner Studium Mertins, Signaltheorie, Vieweg+Teubner Studium Vaidyanathan, Multirate Systems and Filter Banks, Prentice-Hall Series in Signal Processing Oppenheim/Schafer/Buck, Zeitdiskrete Signalverarbeitung, Pearson Studium

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

1.7 Communication Networks (CNE)

Module code	1.6

Semester	Winter semester
Module coordinator	Professorship Communications Engineering (NN)
Qualification objectives	The lecture provides an overview of the structure and design principles of communication networks and their protocols. After completion of this module the students are aware of the current topics and trends in research and development in the field of networking and are able to • design and implement current networking topologies • create ideas on how to advance the state of the art in the science and technology of networking and to underpin these ideas through literature research and practical experiments • appropriately present their work and their ideas to a scientific and/or technical audience
Syllabus	• Introduction to communication networks • Technical topics: - OSI-Layer, Ethernet, Subnetting, IP addressing - TCP/IP protocols, fundamentals of routing (repetition) - Firewall, mobile networks, WLAN, WLAN security, VPN, RADIUS • Survey of current topics in research and development in the field of communication networks
Type of module	Core module in MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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	References are announced at the beginning of the course. Typical choices include: Curriculum of the Cisco Networking Academy Program Stevens: TCP/IP Illustrated, Volume 1: The Protocols

Courses		
Lecturer	**Title of the course**	**Hours per week and semester**
NN	Communication Networks (S)	2
NN	Communication Networks (L)	2

1.8 Optical Communications (OCO)

Module code	1.7

Semester	Winter semester
Module coordinator	Prof. Dr. Sören Peik
Qualification objectives	After completion of this module the students are able to • 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	This module conveys systematic skills to design and apply fiber optic transmission systems and sensor systems. • Introduction to fiber optic systems • Economic significance of photonics • Optical fibers, SM, MM, POF *(optical transmission line)* • Optical sources, LED, LD *(optical transmitter)* • Photodiodes, PIN, APD *(optical receiver)* • Optical interconnection, Splicing *(covered by lab work)* • Optical Systems and Networks *(including lab work)*
Type of module	Compulsory optional Module in MSE, MAI and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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**
Wenke	Optical Communications (S)	2
Wenke	Optical Communications (L)	2

1.9 Satellite Communications (SCO)

Module code	1.8

Semester	Winter semester
Module coordinator	Prof. Dr. Sören Peik
Qualification objectives	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. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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	Maral, Bousquet, *Satellite Communication Systems*, Wiley Books M. Richharia, *Satellite Communication Systems and Design Principles*, MacMillan Larson & Wertz, *Space Mission Analysis and Design* M. Richharia, *Satellite Communication Systems*, MacMillan B. Sklar, *Digital Communications*, Prentice Hall W. Mansfeld, *Satellitenortung und Navigation*, Vieweg

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

Semester	Winter semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	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. After completion of this module the students are able to • understand the basic concepts of image processing and pattern recognition • determine and interpret properties of digital images and their natures • extent 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	• Image Processing - Introduction to image processing - System theoretic concepts of imaging systems - Pixel processing and neighbourhood processing - Image segmentation and shape representation • Pattern Recognition - 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 (2 SWS), laboratory exercises and projects (2 SWS)

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	B. Lehmann, *Image Processing and Pattern Recognition,* lecture notes, Hochschule Bremen T. Hastie, et al., *The Elements of Statistical Learning: Data Mining, Inference and Prediction*, Springer, 2017 B. Jähne, *Digital Image Processing: Concepts, Algorithms and Scientific Applications*, Springer, 2005 C.M. Bishop, *Pattern Recognition and Machine Learning,* Springer, 2007 S. Theodoridis et al., *Introduction to Pattern Recognition - A MATLAB Approach,* Academic Press, 2010

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

1.11 Electronics Engineering Project (EEP)

Module code	1.10 und 2.10

Semester	Winter semester / summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	After completion of this module the students are able to • 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 selfdirected studies within running research projects on electronics engineering under guidance of project manager • aquire 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	• 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 (4 SWS)
Assessment	Written project report or oral project presentation and oral examination (30 min)
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, Henning, Kempen, Kraus, Meiners, Peik, Reinhardt, Wolter	Electronics Engineering Project (S)	4

1.12 Advanced Hardware Verification (AHV)

Module code	2.1 in MSE

Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Stefan Wolter
Qualification objectives	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. After completion of this module the students are able to • write SystemVerilog assertions, bind them to design objects and analyze them with ModelSim/Questa • develop DSP hardware architectures using Xilinx DSP System Generator
Syllabus	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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	Vijaraghavan / Ramanathan, *A Practical Guide for SystemVerilog Assertions*, Springer Cerny / Dudani / Havlicek / Korechmny, *The Power of Assertions in SystemVerilog*, Springer Cohen / Venkataramanan / Kumari, *SystemVerilog Assertions Handbook*, vhdlcohen Publishing Xilinx System Generator for DSP and Xilinx ISE, http://www.xilinx.com

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

Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Ludger Kempen
Qualification objectives	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. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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, *Introduction to Microfabrication*, 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

Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Friedrich Fleischmann
Qualification objectives	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. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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	R. Lerch, *Elektrische Messtechnik*, Springer A.V. Oppenheim, R.W. Schafer: *Digital Signal Processing*, Prentice-Hall A.V. Oppenheim, *Applications of Digital Signal Processing*, Prentice-Hall R.W. Hamming, *Digitale Filter*, VCH-Wiley N. Hesselman, *Digitale Signalverarbeitung*, Vogel P. Addison, *The illustrated wavelet transform handbook*, IOP R. Jamal, A. Hagestedt: *Das Labview-Grundlagenbuch* R.B. Angus, T.E. Hulbert: *VEE Pro: Practical graphical programming*, Springer *Agilent VEE - Practical Graphical Programming,* Agilent

Courses		
Lecturer	**Title of the course**	**Hours per week and semester**
Fleischmann	Computer Aided Data Acquisition (S)	2
Fleischmann	Computer Aided Data Acquisition (L)	2

1.15 Fiber Optic Test and Measurement (FOTM)

Module code	2.2 in MAI

Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Carsten Reinhardt
Qualification objectives	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. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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. Derickson, *Fiber optic Test and Measurement*, Prentice Hall F.L. Pedrotti et al., *Introduction to Optics*, Prentice Hall G.P. Agrawal, *Fiber-Optic Communication Systems*, Wiley Interscience G. Keiser, *Optical Fiber Communications*, McGraw-Hill Intern. W. Daum et al., *Polymer Optical Fibers for Data Communication*, Springer E. Voges, K. Petermann, *Optische Kommunikationstechnik*, Springer

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

1.16 Source and Channel Coding (SCC)

Module code	2.1 in CSE

Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	This module guides the student starting from basic coding schemes to up-to date Turbo and LDPC code constructions. All these codes are essential components of modern IT and communication systems, starting from a CD and DVD player and hard disks to Digital Subscriber Lines (ADSL, VDSL) and mobile communication systems. The course will focus on theory, construction, and algorithms for error correcting codes, and will highlight the application in communication systems. After completion of this module, the students will • know the necessary discrete mathematics and information theory basics • understand coding schemes discussed in communication standards and publications • know the properties of different codes and be able to forecast performances • be able to design own coding schemes, dependent on channel characteristics • be able to implement codes • know the relations to other fields, such as information theory, source coding, and digital signal processing
Syllabus	• Introduction • Convolutional codes basics • Viterbi, SOVA, and BCJR algorithms • Sequential decoding • Ungerböck’s trellis-coded modulation • Trellis shaping • Basics of finite fields • Reed-Solomon codes • Berlekamp-Massey and Euclidean division algorithm • Error values • BCH codes • Construction of long codes from short ones (especially, Turbo and LDPC Codes) • Error probabilities and bounds • Trellis structures of block codes • Multilevel codes and Lattices • Block shaping with shell mapping
Type of module	Core module in CSE, compulsory optional module in MSE and MAI

Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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	W. Henkel, *Channel Coding,* lecture notes Jacobs University, Hochschule Bremen S. Lin, D. J. Costello, Error Control Coding, Prentice Hall, 2004 T. Richardson, R. Urbanke, *Modern Coding Theory*, Cambridge University Press, 2008 R.E. Blahut, *Algebric Codes for Data Transmission*, Cambridge University Press, 2008

Courses		
Lecturer	**Title of the course**	**Hours per week and semester**
Henkel	Source and Channel Coding (S)	2
Henkel	Source and Channel Coding (L)	2

1.17 Microwave Circuits and Systems (MCS)

Module code	2.2 in CSE

Semester	Summer semester
Module coordinator	Prof. Dr. Sören Peik
Qualification objectives	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. After completion of this module the students are able to • 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	• 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 MAI, compulsory optional module in MSE and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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. M. Pozar, *Microwave and RF Design of Wireless Systems*, Addison-Wesley, 2002 R. Ludwig, P. Bretchko, *RF Circuit Design*, Prentice Hall, 2000 R. E. Collin, *Foundations For Microwave Engineering*, McGraw-Hill, 1992 G. Gonzalez, *Microwave Transistor Amplifiers*, Prentice Hall, 1997 P. Abrie, *Design of RF and Microwave Amplifiers and Oscillators*, Artech House, 2000 G. Maral, M. Bousquet, *Satellite Communication Systems: Systems, Techniques and Technology*, Wiley Books, 1998

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

Semester	Summer semester
Module coordinator	Prof. Dr. rer.nat. Thomas Henning
Qualification objectives	This module conveys systematic skills to design and apply laser systems. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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

Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Dieter Kraus
Qualification objectives	This module conveys a comprehensive knowledge and understanding about underwater acoustics and sonar systems. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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

Semester	Summer semester
Module coordinator	Professorship Communications Engineering (NN)
Qualification objectives	Starting from the physical free space path the course develops an understanding of today's digital wireless communications techniques. After completion of this module the students are able to • 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	• 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 (2 SWS), laboratory exercises and projects (2 SWS)
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	T. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2002 J. Schiller, *Mobile Communications*, Pearson, 2003 D.N.C. Tse, P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005

Courses		
Lecturer	**Title of the course**	**Hours per week and semester**
NN	Wireless Communications (S)	2
NN	Wireless Communications (L)	2

1.21 Analogue and Mixed-Signal Circuit Design (AMCD)

Module code	2.9

Semester	Summer semester
Module coordinator	Prof. Dr.-Ing. Mirco Meiners
Qualification objectives	The students possess a thorough understanding of the basic principles, challenges and limitations in analogue and mixed-signal circuit design with • focus on concepts that are unlikely to expire and • preparation for further study of state-of-the-art "fine-tuned" realizations After completion of this module the students have acquired • 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	• Continuous time and switched-capacitor filters • Design of integrators (OTAs) and auxiliary circuits • Analog-to-Digital Converters
Type of module	Core module in MSE, compulsory optional module in MAI and CSE
Teaching and learning methods	Tuition in seminars (2 SWS), laboratory exercises and projects (2 SWS)
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

Semester	Winter semester ORB I - Unit 1 Summer semester ORB II - Unit 2
Module coordinator	Dipl.-Ing., Dipl.-Oec. Birgit Zich
Qualification objectives	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. 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. After completion of the course the students will be able to • 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	The impact of organisational structure on individual and organisational effectiveness; leadership; conflict management; decision-making; motivation and stress. UNIT 1 and UNIT 2 are independent modules. UNIT 1 - The Individual • 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 UNIT 2 - The Group • Foundations of Group Behaviour • Understanding Work Teams • Communication • Leadership • Power and Politics • Conflict, Negotiation, and Intergroup Behaviour

Type of module	Compulsory optional Module in MSE, MAI and CSE
Teaching and learning methods	Tuition in seminars (2 SWS) and projects (2 SWS)
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., 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	R. Kreitner, A. Kinicki*, Organizational Behavior: Key Concepts, Skills & Best Practices*, McGraw Hill, 2012 J. Mattock, *Cross-Cultural Communication: The Essential Guide to International Business*, Kogan Page, 2003 S.P. Robbins, T.A. Judge, *Organizational Behavior,* Prentice Hall, 2016

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

1.23 Project Management and Teambuilding (PMT)

Module code	1.12 und 2.12

Semester	Winter semester PMT I - Teambuilding Summer semester PMT II - Project Management
Module coordinator	Dipl.-Ing., Dipl.-Oec. Birgit Zich
Qualification objectives	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. After completion of the PMT I Unit the students are able to • 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 After completion of the PMT II Unit the students are able to • 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	• PMT I / Team Building is basically divided in three main parts - Self-perception and Belbin's Profile - Team work - 7 Habits of effective people (covey) and team learning • PMT II / Project Management addresses - What constitutes a PROJECT? - Project selection and evaluation - The project life cycle - The project manager - Organisation and planning - Project implementation; scheduling, monitoring and 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	Tuition in seminars (2 SWS) and projects (2 SWS)
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., 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	C. Gray, E. Larson, *Project Management*: *The Managerial Process*, McGraw Hill, 2017 J. Meredith, S. Mantel, S., *Project Management: A Managerial Approach*, Wiley, 2015

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

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	UNIT 1 and UNIT 2 are independent modules. UNIT 1 The Strategy of Productive Systems • Introduction to Operations and Competitiveness • Operations Strategy • Quality Management • Statistical Quality Control Designing Productive Systems • Product and Service Design • Process Planning, Analysis, and Reengineering • Facility Layout • Human Resources in Operations Management • Supply Chain Management UNIT 2 Operating Productive Systems • 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	Tuition in seminars (2 SWS) and projects (2 SWS)
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., 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, *Operations Management*, Pearson, 2016 R.S. Russell, B. W. Taylor, I. Castillo and N. Vidyarthi, *Operations Management: Creating Value Along the Supply Chain*, 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

Semester	Winter semester / summer semester
Module coordinator	Dipl.-Oec. Birgit Zich
Qualification objectives	After completion of this module the students are able to • 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	Contents are defined by the institution offering German language classes according to above given qualification objectives • Fremdsprachenzentrum des Landes Bremen
Type of module	Compulsory optional Module in MSE, MAI and CSE
Teaching and learning methods	Tuition in seminars (4 SWS)
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