OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

Faculty of Electrical Engineering and Information Technology

Module Handbook

for the Master Program

Electrical Engineering and Information Technology

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Technical Note: The module names in the table of contents are linked to the module descriptions. You can return to the table of contents by clicking the link under each module description. Alternatively, you can navigate using the bookmark function of various PDF viewers.

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1 Compulsory Modules

1.1 Digital Communication Systems

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The Student will • gain knowledge about the functions and properties of digital communication systems. • understand the physical principles underlying digital communication. • gain knowledge about the modern wired and wireless digital communication standards. **Contents:** • Introduction • Signal representation • Stochastic processes and noise • Sampling, quantization, and coding • Transmission bandwidth, data rate, and channel capacity • Calculation of error rates • PCM, ASK, PSK, and FSK modulation techniques • OFDM and CDMA • Modeling of wireless channels
Literature	[1] Jerry D. Gibson: Principles of Digital and Analog Communications. Macmillian Publishing Company, 1989, ISBN 0-02-341780-3
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 120 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises, research report and preparation of exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Holger Maune (FEIT-IIKT)

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1.2 Digital Information Processing

Qualification goals and contents of the module	**Learning objectives and acquired competences:** • The participant has an overview of basic problems and methods of digital signal processing. • The participant understands the functionality of a digital signal processing system and can mathematically explain the modus of operation. • The participant can assess applications in terms of stability and other markers. He / She can calculate the frequency response and reconstruction of analogue signals. • The participant can perform these calculations and assessments as well on stochastically excited digital systems. • The participant can apply this knowledge in a field of specialization, e.g. Medical Signal Analysis. **Contents:** • Digital Signals and Digital LTI Systems • Z-Transform and Calculations of Inverse Z-Transforms • System Analysis by Difference Equations • Sampling and Reconstruction • Synthesis and analysis of such systems • Discrete and Fast Fourier Transformations • Processing of Stochastic Signals by LTI-Systems: Correlation Techniques and Model-Based Systems (ARMA). Selected Specialization Topics, e.g. Medical Signal Analysis
Literature	[1] Oppenheim, A; Schafer R (2013): "Discrete Time Signal Processing", 1056 pages, Pearson, ISBN: 978-1292025728 [2] Lathi, B P; Green, R A (2014) "Essentials of Digital Signal Processing", 748 pages, Cambridge University Press, ISBN: 978-1-107-05932-0
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies Knowledge of signals and systems, Analog Fourier transformations
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
examinations prerequisite	Mandatory participation in exercise classes, successful results in exercises
Exam performance	Written exam 120 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Andreas Wendemuth (FEIT-IIKT)

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1.3 Electromagnetic Field Theory

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The Student • will know mathematical basics (vector analysis, operators and integral theorems). • know and understand fundamental laws of electromagnetics, constituting the system of Maxwell's field equations and the boundary conditions for the different fields. • learn how to solve basic problems for static and dynamic fields. **Contents:** • Mathematical fundamentals • Static electric fields • Stationary currents and the static magnetic field • Time-varying electromagnetic
Literature	[1] J.A. Edminster, Schaum's Outline of Electromagnetics - (Schaum's Outline Series), McGraw-Hill Book Company
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 120 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Marco Leone (FEIT-IMT)

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1.4 Electronic Circuits

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The Student will • understand the main function principles on the interface between analog and digital circuit design. • have an overview about the realization of some complex function blocks. **Contents:** • digital analog converters: methods, characteristics, errors, applications • analog digital converters: classification, methods, characteristics, errors, applications • phase locked loops: principle, linear model, circuit design of the function blocks, applications • characteristics, circuit design of some function blocks, design process, introduction VHDL • design and test of digital circuits with programmable logic devices
Literature	[1] U. Tietze, C. Schenk, D. Gamm: Electronic Circuits: Handbook for Design and Applications [2] Springer R. Best: Phase-Locked Loops: Design, Simulation and Applications
Forms of teaching	Lecture, Exercise/Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module in the Master Course "Electrical Engineering and Information Technology".
Examination prerequisites	None
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise/Laboratory Internship Autonomous work: Post processing of lectures, solving of exercises, laboratory work, research report and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Dipl.-Ing. Helmut Bresch (FEIT-IIKT)

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1.5 Power Electronics

Qualification goals and contents of the module	**Learning objectives and acquired competences:** Knowledge about important power electronic circuits shall be imparted. Major methods to understand power electronic circuits are practised. Applications will be demonstrated in the exercise. Cross-links to related fields of electrical and information engineering will be shown. **Contents:** • choppers, buck chopper, boost chopper, phase leg • self commutated bridges with constant voltage DC link, H-bridge, three phase bridge • rectifiers, single and three phase, uncontrolled, half controlled, controlled • AC controllers
Literature	[1] Ned Mohan: Power electronics - converters, applications and design; Wiley, Hoboken NJ, 3rd edition 2003
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies, comprising, fundamentals of electrical engineering, electronics – circuit theory, fundamentals of semiconductor components, mathematics
Usability of the module	Compulsory module for the Master Course "Electrical Engineering and Information Technology" belonging to the field of electrical.
examinations prerequisite	None
Exam performance	Written exam 120 minutes without auxiliaries at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Andreas Lindemann (FEIT-IESY)

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1.6 Power Network Planning (and Operation)

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will learn about steady-state and quasi-stationary algorithms to model and calculate grid states for the purpose of power system planning and operation. This includes the modelling of topology and equipment in natural and modal components, power flow calculation, state estimation, stability and short-circuit calculations as well as modelling of shunt and series faults. **Contents:** • Introduction to the tasks of network planning and system operation • Equation systems to describe steady-state and quasi-steady-state problems in electric power networks • Grid modeling using modal component systems • Basic algorithms of power flow, short-circuit and stability calculations as well as state estimation • Introduction to power grid modelling with MATLAB
Literature	[1] Electric Power System Planning", H. Seifi, M.S. Sepasian, Springer-Verlag, 2011 [2] „Power system engineering : planning, design, and operation of power systems and equipment", Juergen Schlabbach. - Weinheim : WILEY-VCH, 2008
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 120 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Martin Wolter (FEIT-IESY)

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1.7 Project

Qualification goals and contents of the module	**Learning objectives and acquired competences:** • The student knows the typical processes and techniques of scientific work. After passing the module, the student is able to analyze the current state of science and technology and to develop own scientific project ideas. The student can perform a market analysis, develop project specifications and write a scientific project report. • The student knows the basic rules of scientific writing. After completing the module, the student is able to structure a report or thesis, to create significant plots and figures, and to cite all used sources. The student is very well aware of the problem of plagiarism. The student is also able to defend his project results in an oral presentation. **Contents:** **Part 1 (Non-technical Project Seminar)** The seminar consists of four lectures with the topics • Literature survey and reference management • Rules of scientific writing, Visualization, schematics and diagrams • Effective oral presentations,writing a short paper (1 page) and giving a short presentation (5 minutes) about a given topic **Part 2 (Non-technical Project Work)** • Application of the obtained skills on a specific topic under supervision of the project supervisor **Schedule** Lecture Week — Event 01 to 04 — Lectures of part 05 — Short paper submission/review of part 1 06 — Short presentations of part 1, issue of the certificates of attendance of part 1 07 to 14 — Part 2
Literature	[1] R. C. Dorf, R. H. Bishop: Modern Control Systems, Pearson Education, 2005
Forms of teaching	Research project
Requirements for participation	Part 2 of the module can only be attended if the part 1 was successfully passed
Usability of the module	Compulsory module for the Master's course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Research project (PRO)
Credit points and grades	5 CP = 150 h Grading scale as per examination regulations
Work effort	The first part of the module is accounted with 12 hours of attendance and 8 hours of autonomous work. The remaining time for the second part of the module is then 30 hours of attendance and 100 hours of autonomous work.
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Dr.-Ing. Magdowski (FEIT-IMT) in conjunction with work supervisor

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1.8 Systems and Control

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will learn how to • mathematically describe and analyses dynamic systems. • design feedback control systems using frequency and time domain techniques. • efficiently apply modern software tools to achieve the aforementioned goals. **Contents:** • Introduction to control systems • Mathematical models of systems • Feedback control systems characteristics • The performance of feedback control systems • The stability of linear feedback systems • The root locus method • Frequency response method • The design of state variable feedback systems (Full-state feedback design and observer design methods)
Literature	[1] R. C. Dorf, R. H. Bishop: Modern Control Systems, Pearson Education, 2005
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory module for the Master's course "Electrical Engineering and Information Technology", optional module for students of the "International Max-Planck Research School" and the Master's course "Chemical Process Engineering".
examinations prerequisite	None
Exam performance	Written exam 120 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Achim Kienle (FEIT-IFAT)

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2 Technical Elective Modules

2.1 Field of Study Automation Systems

2.1.1 Automation Lab

Qualification goals and contents of the module	**Learning objectives and acquired competences:** To develop practical skills in the field of (process) automation. **Contents:** The acquired knowledge from the courses "Systems and Control" and "Distributed Control Systems" should be applied to practical examples/systems of automation. For these purposes miscellaneous experiments will be conducted.
Literature	According to modules "Systems and Control" and "Distributed Control Systems"
Forms of teaching	Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies, Systems and Control, Distributed Control Systems
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test after every experiment
Credit points and grades	2 SWS / 5 CP = 150 h (28 h time of attendance + 122 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Laboratory Internship Autonomous work: Post processing and preparation of Laboratory Internship
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Achim Kienle (FEIT-IFAT)

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2.1.2 Digital Automation Systems

Qualification goals and contents of the module	**Learning objectives and acquired competences:** At the end of the course, the students will have core competencies in the designand construction of distributed digital automation systems. They will understand how to plan and implement the integration of various automation componentsand which automation and information technologies are used. Students acquire the ability to recognize and interpret abstract automation and information technology models and to grasp their interrelations in order to create functional automation systems. Through the exercises, the students are able to deepen their knowledge and skills in a research-oriented way and to apply and evaluate them in complex problems. **Contents:** • Models and methods for handling automation systems • Information models • Integration technologies • Principles of descriptive description methods for technical systems
Literature	[1] Wolfgang Mahnke, Stefan-Helmut Leitner, Matthias Damm: OPC Unified Architecture. Springer-Verlag Berlin Heidelberg 2009. ISBN 978-3-540-68898-3, DOI 10.1007/978-3-540-68899-0, e-ISBN 978-3-540-68899-0 [2] Riedl, M., Naumann, F.: EDDL. Vulkan-Verlag. ISBN-10: 3835632434. Standard books UML and XML.
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering, Computer Science or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology" and "Digital Engineering".
examinations prerequisite	None
Exam performance	Written or oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises, preparation of presentation and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Christian Diedrich (FEIT-IFAT)

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2.1.3 Non-linear Control

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students will be able to describe and model nonlinear systems, to analyze the system dynamic behaviour such as stability considering different stability concepts, and to design controllers for nonlinear systems. **Contents:** • Review of mathematical basics • Review of linear MIMO systems • Lyapunov stability • Concepts of BIBO stability • Passivity • I/O linerarization • Design of controllers for nonlinear systems
Literature	[1] D.E. Kirk. Optimal Control Theory – An Introduction. Prentice-Hall Inc., Englewood Cliffs, New Jersey, 2004 [2] D.P. Bertsekas. Dynamic Programming and Optimal Control, volume 1. Athena Scientific Press, Belmont, MA, 2006 [3] R. Bellman. Dynamic Programming. Princeton University Press, Princeton, New Jersey, 1957
Forms of teaching	Lecture, Exercise/Tutorial
Requirements for participation	Knowledge in control theory
Usability of the module	Optional module for the Master Courses "Systemtechnik und Technische Kybernetik". Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test at the end of the module and project report
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	time of attendance: 2 SWS Lecture, 1 SWS Exercise/Tutorial autonomous work: Post processing of lectures, preparation of project work/report and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	PD Dr. sc. techn. ETH Eric Bullinger (FEIT-IFAT)

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2.1.4 Process Control

Qualification goals and contents of the module	**Learning objectives and acquired competences:** Students should • learn fundamentals of multivariable process control with special emphasis on decentralized control • gain the ability to apply the above mentioned methods for the control of single and multi unit processes • gain the ability to apply advanced software (MATLAB) for computeraided control system design **Contents:** 1. Introduction 2. Process control fundamentals • Mathematical models of processes • Control structures • Decentralized control and Relative gain analysis • Tuning of decentralized controllers • Control implementation issues 3. Case studies 4. Plantwide control
Literature	[1] B. W. Bequette: Process Control, Modeling Design and Simulation, Pearson Education, 2003
Forms of teaching	Lecture, Exercise/Tutorial
Requirements for participation	Basic knowledge in control theory
Usability of the module	Compulsory module for the Master Course "Elektrotechnik und Informationstechnik" Option "Automatisierungstechnik". Optional module for the Master Courses "Systemtechnik und Technische Kybernetik" and "Chemical Process Engineering", for students of the International Max-Planck Research School. Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test at the end of the module and project report
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise/Tutorial Autonomous work: Post processing of lectures, preparation of project work/report and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Achim Kienle (FEIT-IFAT)

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2.1.5 State Estimation

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The module provides an introduction to state estimation and model based measurement systems. The students are enabled to judge if the available measurement data are sufficient to reconstruct all states of a process model, or which additional measurement information is required. At the end of the course the students are able to choose suitable state estimation techniques for linear and nonlinear systems. Special emphasis is on the Kalman filter. The students are enabled to derive the filter equations, to implement them and to choose the tuning parameters. The acquired methods are deepened in computer exercises. In miniprojects, the students obtain practical experience in programming and testing state estimation algorithms. **Contents:** • Observability criteria for LTI systems • Luenberger observers for LTI systems with one or several measurements • Kalman filter for linear time-discrete systems • Kalman filter for linear time-continuous systems • Extended Kalman filter for nonlinear time-discrete and timecontinous systems • Unscented Kalman filter • Kalman filter with constrained filter update • Bayesian estimators • Outlook on observers for nonlinear systems
Literature	[1] A. Gelb, Applied Optimal Estimation, M.I.T. Press, 1974. [2] D. Luenberger, Introduction to Dynamic Systems. Wiley, 1979. [3] D. Simon, Optimal State Estimation, John Wiley, 2006.
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor's degree in Systems Engineering and Technical Cybernetics or a related course of study
Usability of the module	Optional module for the Master Courses "Systemtechnik und Technische Kybernetik", "Elektro- und Informationstechnik", "Mechatronik", "Biosystemtechnik" und "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam at the end of the module
Credit points and grades	4 SWS / 5 CP = 150 h (56 h time of attendance + 94 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 2 SWS Exercise Autonomous work: Rework of lectures, solving of exercices -/project tasks and preparation exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Dr.-Ing. Christian Kunde (FEIT-IFAT)

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2.2 Field of Study Information and Communication Technology

2.2.1 Digital Information Processing Laboratory

Qualification goals and contents of the module	**Learning objectives and acquired competences:** • The participant has an overview of basic methods of applied digital signal processing. • The participant can transform physiological knowledge into technical digital signal processing methods. • Selected Feature Space transformations and their applications are known. • Gaussian Production System Architectures are being estimated under Maximum-Likelihood Assumptions **Contents:** • Digital Signals and Digital LTI Systems • Synthesis and analysis of such systems • Selected Digital Filters • Discrete and Fast Fourier Transformations • Selected Feature Space transformations • Gaussian Production System Architectures Characteristics of Human Speech
Literature	[1] Oppenheim, A; Schafer R (2013): "Discrete Time Signal Processing", 1056 pages, Pearson, ISBN: 978-1292025728 [2] Lathi, B P; Green, R A (2014) ‘‘Essentials of Digital Signal Processing’’, 748 pages, Cambridge University Press, ISBN: 978-1-107-05932-0
Forms of teaching	Seminar, Laboratory Internship
Requirements for participation	Credits obtained in the module „Digital Information Processing" (Prof. Wendemuth)
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
examinations prerequisite	Successful laboratory attendance (Praktikumsschein), and grading based on the average of the four best graded laboratory reports.
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 3 SWS Seminar + Laboratory Internship Autonomous work: Pre- and post processing of course, preparation of exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Andreas Wendemuth (FEIT-IIKT)

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2.2.2 FPGA and Microcontroller Programming 1 und 2

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will • have an overview about the design process of FPGAs and Microcontrollers Contents. • Programmable logic devices: overview, circuit design of special function blocks, introduction in the hardware description languages and their realization. • Microcontroller: overview, description of special function blocks from the view of circuit design, realization of projects in assembly language and C. • simulation and methods of debugging.
Literature	Documentation available: www.xilinx.com
Forms of teaching	Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies, Electronic Circuits
Usability of the module	Optional module in the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	5 SWS / 5 CP = 150 h (70 h time of attendance + 80 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance in summer semester: 2 SWS Laboratory Internship Time of attendance in winter semester: 3 SWS Laboratory Internship Autonomous work: Post processing, preparation of laboratory work, research report and exam
Availability	Every year Start in the summer semester
Duration of the module	Two Semesters
Responsible lecturer	Dipl.-Ing. Helmut Bresch (FEIT IIKT)

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2.2.3 Image Coding

Qualification goals and contents of the module	**Learning objectives and acquired competences:** Learn about methods and techniques of image coding as essential part of image communication. Problems of image acquisition are treated as far as they are relevant for image coding. **Contents:** • Fundamentals • Basics of human perception • TV Systems • Basics of information • Quantisation • Lossless Coding • Lossy Coding • DPCM • Interframe Prediction • Transform Coding • Content based and semantic Coding • Standards and applications
Literature	[1] John W. Woods: Multidimensional signal, image, and video processing and coding, Academic Press, 2012
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises, preparation of presentation and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Dr.-Ing. Gerald Krell (FEIT-IIKT)

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2.2.4 Introduction to RF Communication Systems

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will • understand the differences between low-frequency and radio-frequency networks. • gain knowledge about radio-frequency communication systems. • be capable of analyzing and designing selected components of radio-frequency communication systems. **Contents:** • Introduction • Transmission lines • Scattering parameters • Matching networks and filters • Attenuators, phase shifters, directional couplers, and circulators • Microwave amplifiers and oscillators
Literature	[1] R.E. Collin, "Foundations for Microwave Engineering", McGraw-Hill, 1966
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
examinations prerequisite	None
Exam performance	Written exam 90 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises, research report and preparation of exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Abbas Omar (FEIT-IIKT)

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2.2.5 Medical Imaging - CT

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will • understand the system theory of imaging systems. • learn the functional principle of the computed tomography. • understand the mathematical principle of tomographic reconstruction. • have an overview about the current research work in the area of tomographic imaging. **Contents:** Starting with the system theory of imaging systems, the first part of the module is focused on the physical properties of x-rays and it's interaction with manner. The second part deals with X-ray based standard radiography. The third and final part brings the mathematical methods of tomographic image reconstruction into focus. The particular content is: • System theory of imaging systems • Basic principle of underlying physics • X-ray tubes and detectors • Radiography • Reconstruction: Fourier-based principle, Filtered back projection, Algebraic approach, statistical methods • Beam-geometry: Parallel-, Fan- and Conebeam • Implementation • Artefacts and Adjustment
Literature	Provided by e-learning system
Forms of teaching	Lecture, Tutorial
Requirements for participation	Digital Signal Processing, Fundamental Physics
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Tutorial Autonomous work: Rework of lectures and tutorials, preparation of exercises and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Georg Rose (FEIT-IMT)

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2.2.6 Speech Recognition

Qualification goals and contents of the module	**Learning objectives and acquired competences:** • The participant understands basic problems and methods of automatic speech recognition with Hidden Markov Models. • The participant understands the functionality of the relevant computer modules in speech recognition and can mathematically explain the modus of operation. • The participant knows specific requirements for speech recognition. These can include reliability, availability, speaker verification. • The participant knows specific requirements and differences in command, dictation and dialogue mode, particularly in the field of applications (e.g. medical) and support systems. **Contents:** • Production and Reception of Natural Speech • Feature Extraction • Classification Techniques • Hidden Markov Models (DTW, Viterbi, Baum-Welch) • Language Models • Aspects of robust Speech Recognition: adaptivity, reliability, availabilty, speaker verification. • Practical Speech Recognition Systems Design
Literature	[1] Rabiner, L & Juang, B (1993): „Fundamentals of Speech Recognition“, 507 pages, Prentice Hall, ISBN: 0-13-015157-2
Forms of teaching	Lecture, Exercise, Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies Knowledge of Digital Signal Processing
Usability of the module	Optional module for the Master Course “Electrical Engineering and Information Technology”.
examinations prerequisite	Mandatory participation in exercise classes, successful results in exercises
Exam performance	Written exam 90 minutes at the end of the module
Credit points and grades	4 SWS / 5 CP = 150 h (56 h time of attendance + 94 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise, 1 SWS Laboratory Internship Autonomous work: Post processing of lectures, preparation of exercises and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Andreas Wendemuth (FEIT-IIKT)

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2.2.7 Theoretical Neuroscience II

Qualification goals and contents of the module	**Learning objectives and acquired competences:** Based on Chapters 7-10 of Dayan und Abbott. Rate models of network dynamics, synaptic plasticity, reinforcement learning, and generative models. Linear models of neural networks, dynamic analysis of state-space, eigenvalue analysis of steady-states, models of activity-dependent plasticity, associative learning with neural networks, modern theories of reinforcement learning (Rescorla-Wagner, temporal-difference, actor-critic models), and abstract approaches to representational learning and generative models (expectation maximization, principal components, independent components). To develop a deeper understanding and to acquire applied and practical skills, students perform weekly homework assignments with Matlab programming. A passing grade on all assignments is required for admission to the final exam. The tutorial is open to all students and provides an opportunity for more extensive questions and discussions of the lecture material. It is particularly recommended for students with a weaker background in mathematics and physics.
Literature	[1] Dayan and Abbott (2001) Theoretical Neuroscience, MIT Press
Forms of teaching	Lecture, Exercise
Requirements for participation	Required: basic knowledge in Calculus and Linear Algebra Useful: basic knowledge in programming
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	5 SWS / 5 CP = 150 h (70 h time of attendance + 80 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 3 SWS Lecture, 2 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises, project work and preparation of exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. Jochen Braun (FNW-IBIO)

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2.3 Field of Study Microsystems

The option "Microsystems" is not offered at the moment.

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2.4 Field of Study Power and Energy

2.4.1 Control of AC Drives (Regelung von Drehstrommaschinen)

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students will get knowledge about the dynamic models of the usual AC electric machines and the space vector representation. They will be able to understand the algorithms for the control of AC drives and to adjust their parameters. They will also be capable to asses advantages and drawback of the different machine types and control algorithms depending on a given application. **Contents:** • Optimization of control loops • The inverter as an power electronic actuator • Space vector representation • Model of the permanent magnet synchronous machine (PMSM) • Field oriented control of the PMSM • Model of the Induction machine (IM) • Field oriented control of the IM • Direct torque control (DTC)
Literature	[1] De Doncker et.al.: Advanced Electrical Drives, Analysis, Modeling, Control. Springer Science+Business Media B.V. 2011 [2] Mukhtar Ahmad: High Performance AC Drives, Modelling Analysis and Control. Springer-Verlag 2010
Forms of teaching	Lecture, Exercise
Requirements for participation	Knowledge of Control Systems and Power Electronics
Usability of the module	Compulsory module for the Master Courses ETIT-EE and EE-RE. Optional module for the Master Courses EEIT, ETIT, MTK and STK.
examinations prerequisite	None
Exam performance	Written exam 90 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, preparation of project report and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Roberto Leidhold (FEIT-IESY)

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2.4.2 Digital Protection of Power Networks

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students will get acquainted with the knowledge about power systemprotection concepts as well as related digital signal processing algorithms. The students will be able to use appropriate means as well as prepare settings of protection for any network elements and structures. **Contents:** • Concepts and requirements of power system protection • Protection of particular network elements ◦ power lines ◦ transformers ◦ generators ◦ busbars • Digital signal processing for protection purposes ◦ digital filtering ◦ calculation of protection criteria ◦ decision-making and logic • Adaptive and intelligent protection systems ◦ adaptive and multi-criteria systems ◦ artificial intelligence – based systems • wide-area protection concepts
Literature	
Forms of teaching	Lecture, Exercise
Requirements for participation	Knowledge of power system basics
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 120 minutes at the end of the module and project report
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, preparation of project report and exam
Availability	Every year in the summer semester
Duration of the module	One Semester (block-wise at the end of semester)
Responsible lecturer	Prof. Dr.-Ing. habil. Waldemar Rebizant (WUST-FEE)

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2.4.3 Electromagnetic Compatibility (EMC)

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students gain information on the fundamental concepts, principles and measurement techniques of electromagnetic compatibility (EMC). At the end of the module, they are able to understand and apply measures to improve the EMC of electric and electronic systems. They will also be able to analyze the EMC of electrical systems. **Contents:** • Introduction • EMC regulation • EM coupling, shielding, filtering • EMC analysis • Interference models for special applications • EMC measures in electronic circuits • Measurement techniques
Literature	[1] K.-H. Gonschoreck, R. Vick: Electromagnetic Compatibility for Device Design and System Integration. Springer Verlag
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology" and "Medial System Engineering".
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	4 SWS / 5 CP = 150 h (56 h time of attendance + 94 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 2 SWS Exercise Autonomous work: Post processing of lectures and laboratory work, preparation of exercises, laboratory work, research report and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Ralf Vick (FEIT-IMT)

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2.4.4 Power Electronic Components and Systems

Qualification goals and contents of the module	**Learning objectives and acquired competences:**
	Knowledge about power semiconductor components as part of power supply or drive systems shall be imparted, considering the mutual interaction between component and system level. Applications will be demonstrated in the exercise. To strengthen the competence for interdisciplinary work, consideration of questions of reliability shall show cross-links to related fields of engineering.
	
	Contents:
	• power electronic components
	  ◦ functionality, ratings and characteristics of IGBT, MOSFET and diode
	  ◦ packaging and assembly
	• power electronic systems
	  ◦ component stress in selected power supply and drive systems
	  ◦ dimensioning
	  ◦ reliability

Literature	[1] Ned Mohan: Power electronics - converters, applications and design; Wiley, Hoboken NJ, 3rd edition 2003
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies and Master Course "Power Electronics"
Usability of the module	Selectable module for the Master Course "Electrical Engineering and Information Technology", belonging to the field of electrical energy systems.
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, preparation of exercises and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Andreas Lindemann (FEIT-IESY)

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2.4.5 Power System Economics and Special Topics

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will learn • the main principles of high voltage and high current engineering. • the principles of materials used as isolator. • how to calculate economics of power systems. • how the energy market is structured and organized. • how to calculate the reliability and ability of power grid components. • how energy trading is organized and power prices will be calculated. **Contents:** • Electric power market and its liberalization • Financing account • The costs of transmission • Liberalization of European energy market • Energy trading • Network reliability • Network planning • Computing in network planning • High voltage measurement • High voltage and high current generation • Isolation materials • Isolation technology engineering • Use of high voltage technology in testing
Literature	[1] "Fundamentals of Power System Economics", Daniel S. Kirschen, Goran Strbac, John Wiley & Sons Ltd, 2004 [2] "Power System Economics: designing marktes for electricity", Steven Stoft. Wiley Interscience, 2002
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 90 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 1 SWS Lecture, 2 SWS Exercise Autonomous work: Post processing of lectures, preparation of exercises and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Martin Wolter (FEIT-IESY)

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2.4.6 Renewable Energy Sources

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will learn about energy conversion processes of different types of renewable energy sources, the regulatory framework and the challenges of grid integration. Thereby, wind energy, photovoltaic systems, biomass and fuel cells are focused. Grid integration includes possibilities and limitations of energy storage as well. **Contents:** • Introduction to Renewable sources • Legal Framework, priority and subsidies • Functionality of energy conversion • Introduction to Fuel Cells • Introduction to energy storage
Literature	[1] "Renewable Energy Systems Fundamentals, Technologies, Techniques and Economics", Z. A. Styczynski, N. I. Voropai (Editors), ISBN: 978-3-940961-42-6, 2010 [2] "Power Conversion of Renewable Energy Systems", E. F. Fuchs, Mohammad A. S. Masoum, Springer-Verlag, 2011
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Written exam 90 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, preparation of exercises and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. habil. Martin Wolter (FEIT-IESY)

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2.5 General

2.5.1 Integrated Project

Qualification goals and contents of the module	**Learning objectives and acquired competences:** This module serves to improve and apply the knowledge gained in a research-related topic. The student will develop his skills to work on a scientific topic under supervision. He will learn to perform research including accessible literature. In addition, the student will be able to develop his own research project. **Contents:** The content of teaching is largely determined by the research project.
Literature	
Forms of teaching	Scientific project
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Research project (PRO)
Credit points and grades	6 SWS / 10 CP = 300 h (84 h time of attendance + 216 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 6 SWS Scientific project Autonomous work: Post processing of seminars and tutorials, preparation and performance of scientific work, preparation of presentations and a project
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Supervisor of the project

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2.5.2 Introduction into Medical Imaging Technologies

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The course gives an introduction to medical imaging technologies. While the famous clinical techniques, i.e. MRI, PET, SPECT, CT and projectional radiography are studied shortly, the aim is to present also other modern techniques.For every imaging technique we will go quickly into the image (re-)construction/data acquisition and look at the key technologies that are needed to realize the individual imaging setups. **Contents:** • Ultrasound Imaging • Impedance Tomography • Infrared Medical Imaging • Optical Coherence Tomography • Magnetic Nano-Particle Imaging • Magnetic Resonance Imaging • X-ray: Absorption, Dark Field & Phase Contrast Imaging • Xray: Computed Tomography, Diffraction Computed Tomography, Coherent Scatter Imaging • Nuclear medicine imaging: Scintigraphy, Single PhotonEmission Computed Tomography, (TOF) Positron Emission Tomography
Literature	[1] Diakides, Medical Infrared Imaging - Principles and Practices (2012) [2] Plonsey, Bioelectromagnetism - Principles and Applications of Bioelectricand Biomagnetic Fields (1995) [3] Bouma & Tearney, Handbook of Optical Coherence Tomography (2001) [4] Paganin, Coherent X-ray Optics (2006) [5] Bech, X-ray imaging with a grating interferometer - PhD thesis (2009) [6] Scherer, Grating based X-ray phase contrast mammography (2016) [7] Zeng, Medical Image Reconstruction (2010) [8] Bushberg, The Essential Physics of Medical Imaging (2011) [9] Oppelt, Imaging systems for medical diagnostics (2005)
Forms of teaching	Lecture, Tutorial
Requirements for participation	Basics of Radiation Physics and Image Science
Usability of the module	Master program
examinations prerequisite	50% correct answers to exercise sheets + short talk
Exam performance	Written exam of 90 minutes at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Preparation of the lectures and tutorials, preparation of the exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Christoph Hoeschen (FEIT-IMT)

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2.5.3 Power Systems Control and Optimization

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students should: • learn fundamentals of automatic power system operation. • gain the ability to provide a stability analysis and design control laws for specific parts of a power system. • learn how to formulate and solve different kinds of optimization problems for power systems. **Contents:** • Relay control, automatic emergency control • Generation and frequency control • Voltage stability and automatic voltage regulator • Economic dispatch problem • Unit commitment • Optimal power flow
Literature	provided by e-learning system
Forms of teaching	Lecture, Exercise
Requirements for participation	None
Usability of the module	Optional module of the Master Courses.
examinations prerequisite	none
Exam performance	Oral test at the end of the module and project
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	time of attendance: 2 SWS Lecture, 1 SWS Exercise autonomous work: Rework of lectures and tutorial, preparation of exercises and exam
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	PD Dr.-Ing. Stefan Palis (FEIT-IFAT)

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2.5.4 Ultrasonic Sensors for Imaging

Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students gain information on the fundamental concepts and principles of ultrasonic sensors and the characteristics and requirements of ultrasonic sensors for imaging. At the end of the module they are able to engineer ultrasonic sensors and apply the physics behind signal analysis for ultrasonic imaging. They will be able to join interdisciplinary groups working on ultrasonic imaging, develop new sensors and imaging schemes. **Contents:** • Principles of generation and detection of ultrasound • Fundamentals of acoustic wave propagation • Methods of signal optimization and signal extraction • New trends in ultrasonic sensor development and imaging principles
Literature	[1] Sanches, J.M., Ultrasound Imaging: Advances and Applications, Springer 2012 (Link: zum Buch) [2] Scabo, T.L., Diagnostic Ultrasound Imaging, Elsevier,2007
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Optional module for the Master Course "Electrical Engineering and Information Technology".
examinations prerequisite	None
Exam performance	Oral test at the end of the module
Credit points and grades	3 SWS / 5 CP = 150 h (42 h time of attendance + 108 h autonomous work) Grading scale as per examination regulations
Work effort	Time of attendance: 2 SWS Lecture, 1 SWS Exercise Autonomous work: Post processing of lectures, solving of exercises and preparation of exam
Availability	Every year in the summer semester
Duration of the module	one Semester
Responsible lecturer	Prof. Dr.-Ing. Ulrike Steinmann (FEIT-IFAT)

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3 Master Thesis

3.1 Master Thesis

Qualification goals and contents of the module	**Learning objectives and acquired competences:** Students can work in a research-oriented and scientific manner. They can select and apply suitable scientific methods to solve a defined problem and critically evaluate and classify the results obtained. They can identify information needs, find and obtain information. Students are able to write a research-oriented scientific text to the extent of a Master's thesis. The student is able to present this work and to answer questions scientifically. **Contents:** after arrangement with the advisor
Forms of teaching	term paper, presentation
Requirements for participation	see study and examination regulations
Usability of the module	There is no interaction with other modules.
examinations prerequisite	According to the requirements of the study and examination regulations
Exam performance	term paper, presentation Submission of a scientific text with novelty character prepared by the participant himself/herself, as part of a Master's thesis as well as the presentation and defence of the thesis.
Credit points and grades	30 CP = 900 h autonomous work Grading scale as per examination regulations
Work effort	After topic-specific agreement with the advisor autonomous work: Research-oriented scientific work
Availability	Every year in the summer semester or winter semester
Duration of the module	One Semester
Responsible lecturer	Supervisor of the Master Thesis

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