OTTO VON GUERICKE
UNIVERSITÄT
MAGDEBURG

Faculty of Electrical Engineering and Information Technology

Module Handbook

for the Master Program

Electrical Engineering and Information Technology

Version from 01. July 2026

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

English title	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
Language	English
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	N.N. (FEIT-IIKT)

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1.2 Digital Information Processing

English title	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
Language	English
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

English title	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
Language	English
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

English title	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
Language	English
Forms of teaching	Lecture, Exercise/Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory module in the Master Course "Electrical Engineering and Information Technology".
Examinations prerequisites	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/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	Prof. Dr.-Ing. Fabian Lurz (FEIT-IIKT)

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1.5 Power Electronics

English title	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
Language	English
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 System Analysis (previously Power Network Planning (and Operation))

English title	Power System Analysis
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student will learn about steady-state and quasi-steady-state 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, small-signal and transient stability and short-circuit calculations as well as modelling of shunt and series faults. **Contents:** • Introduction to the tasks of power system analysis • 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] Lecture script available at www.lena.ovgu.de [2] J. Grainger, W. Stevenson, G. Chang: "Power System Analysis", McGraw-Hill; 2. Edition, 2016. [3] A. Abur, A. Exposito: "Power System State Estimation", Marcel Dekker Inc., New York, 2004. [4] P. Kundur, O. Malik: "Power System Stability and Control", McGraw-Hill; 2. Edition, 2022.
Language	English
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 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 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

English title	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 will be offered as a one week block seminar consisting of theoretical lectures and practical seminars covering the following topics: • Literature survey and reference management • Good scientific practice and good citation practice • Structure of a written scientific work • Design and delivery principles for effective scientific presentations • Use of AI-based tools in scholarly work The final deliverable of the Part 1 seminar is a scientific poster (A0) about a research topic in EEIT including a short oral presentation (5 minutes). **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
Language	English
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.

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Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Dr.-Ing. Melanie Fachet (FEIT-IMT) in conjunction with work supervisor

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1.8 Systems and Control

English title	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
Language	English
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 Deepening Automation Systems

2.1.1 Advanced Linear Control

English title	Advanced Linear Control
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The module considers state-space methods for analysis and control of linear time-invariant dynamical systems with multiple inputs and multiple outputs (MIMO LTI systems), both for continuous-time systems as well as in the discrete-time setting. Upon successful completion, students are able • to analyze dynamical systems with respect to stability, controllability, and observability as well as related properties, • to know and use special state representations (like the controller canonical form, the Jordan form or a Kalman decomposition), • to design state feedback controllers by methods including eigenvalue assignment and the LQR approach, and • to design state observers to reconstruct unmeasured state components. **Contents:** • introduction into state-space representations and theory • system properties of continuous-time and discrete-time LTI systems • design of state feedback controllers and state observers
Literature	[1] P.J. Antsaklis, A.N. Michel, Linear Systems, Birkhäuser, 2006 [2] K. Ogata, Modern Control Engineering, Pearson, 2010 [3] W.J. Rugh , Linear System Theory, Prentice Hall, 1996
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	None
Usability of the module	Compulsory elective 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: study of lecture materials, solution of exercise problems, exam preparation
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Nicole Gehring (FEIT-IFAT)

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2.1.2 Automation Lab

English title	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"
Language	English
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	Compulsory elective 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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2.1.3 Digital Automation Systems

English title	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.
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering, Computer Science or related studies
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and "Digital Engineering".
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, preparation of presentation and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Lisa Underberg (FEIT-IFAT)

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2.1.4 Dynamics of Distributed Parameter Systems

English title	Dynamics of Distributed Parameter Systems
Qualification goals and contents of the module	**Learning objectives and acquired competences:** Upon completion of the modul, student are able • to comprehend the modeling of distributed parameter systems, • to solve linear partial differential equations with constant coefficients, • to analyze basic properties of the system classes considered, and • to design feed-forward and feedback controllers for time delay systems and simple linear partial differential equations. **Contents:** The course focuses on a class of systems, whose quantities not only depend on time but on a spatial variable as well. These infinite-dimensional or distributed parameter systems are represented using partial differential equations. The course discusses different technological application examples (such as a heat exchanger, a pipe reactor or a flexible robot arm) in order to give a first introduction in the analysis and control of this class of systems: • Modeling of distributed parameter systems • Solution and stability analysis of distributed parameter systems • Flatness-based control design • Backstepping control of distributed parameter systems
Literature	[1] D. Franke, Systeme mit verteilten Parametern, Springer Verlag, 1987. [2] J. Rudolph, Flatness Based Control of Distributed Parameter Systems, Shaker Verlag, 2003. [3] M. Krstic und A. Smyshlyaev, Boundary Control of PDEs, SIAM, 2008. [4] E.C. Zachmanoglou und D.W. Thoe, Introduction to Partial Differential Equations with Applications, Dover Publications, 1986.
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Control Engineering
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and other Master Courses. Compulsory module in other Master Courses of the FEIT.
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 (every two weeks) Autonomous work: Post processing of lectures, solving of exercises and exam preparation
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Nicole Gehring (FEIT-IFAT)

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2.1.5 Machine Learning, Dynamical Systems, and Control

English title	Machine Learning, Dynamical Systems, and Control
Qualification goals and contents of the module	This module gives an introduction to artificial intelligence approaches in dynamical systems and control, and shows connections between systems theory and machine learning, enabling the students to design modelling and control approaches that incorporate learning for dynamical systems approximation and controller design. The lectures are complemented with examples and a project in Matlab or Python. **Learning objectives and acquired competences:** Upon completion of the module, the student will be able to • understand the core approaches of learning theory for dynamical systems and control, • analyse machine learning algorithms for their usability to solve dynamical problems, and design classifiers for dynamical data and controllers incorporating artificial intelligence. **Contents:** • Introduction to machine learning • Static approaches in artificial intelligence • Dynamical approaches in artificial intelligence, reinforcement learning • Connecting systems theory with machine learning (Willems' Fundamental Lemma, Koopman Theory, adaptive control, system identification, dynamic programming)
Literature	[1] Steven L. Brunton & Steven L. Kutz (2022) "Data Driven Science & Engineering - Machine Learning, Dynamical Systems, and Control", Cambridge University Press, 2nd edition
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Control theory (frequency domain and state space approaches)
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and other Master Courses of the FEIT.
Examinations prerequisite	Exercise certificate
Exam performance	Successful presentation of a project and 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: Preparation and follow-up work for the lectures, working on the project and exam preparation
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	PD Dr. sc. techn. ETH Eric Bullinger (FEIT-IFAT)

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2.1.6 Nonlinear Control

English title	Nonlinear 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
Language	English
Forms of teaching	Lecture, Exercise/Tutorial
Requirements for participation	Knowledge in control theory
Usability of the module	Compulsory elective module for the Master Courses "Systemtechnik und Technische Kybernetik". Compulsory elective 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. Nicole Gehring (FEIT-IFAT)

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2.1.7 Optimal Control

English title	Optimal Control
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The module introduces the formulation, theory, solution and application of optimal control theory/dynamic optimization. The students are enabled to formulate and solve optimal control problems appearing in many applications spanning from engineering, process control up to medicine and systems biology. The students will be able to formulate optimal control problems on standard form from specifications on dynamics, constraints and control objective as well as to explain how various control objectives affect the optimal performance. They will be able to use the methods developed in the course to design open and closed loop controllers for optimal control problems. **Contents:** • Static optimization • Calculus of Variation • Dynamic programming, principle of optimality • Hamilton-Jacobi-Bellman equation • Pontryagin maximum principle • Infinite and finite horizon optimal control, LQ optimal control • Model predictive control • H-infinity, Game theory • Numerical approaches for solving optimal control problems With application examples from various fields such as electrical and mechanical engineering, economics, and biology.
Literature	[1] D. Cline (2021). Variational Principles in Classical Mechanics. 3rd ed. University of Rochester Campus Libraries. [2] H.-P. Geering (2007). Optimal Control with Engineering Applications. 2007th ed. Berlin, Germany: Springer. [3] D. Liberzon (2012). Calculus of Variations and Optimal Control Theory - A Concise Introduction. 2nd ed. Princeton University Press. [4] G. Meinsma & A. van der Schaft (2023). A Course on Optimal Control. Springer.
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Control theory (frequency domain and state space approaches) Recommended: Advanced Linear Control
Usability of the module	Compulsory elective module for the Master Course EEIT, and other Master Courses. Compulsory module in other Master Courses of the OVGU.
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 exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	PD Dr. sc. techn. ETH Eric Bullinger (FEIT-IFAT)

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2.1.8 Process Control

English title	Process Control
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The students learn about the fundamentals of multivariable process control with special emphasis on decentralized control. They will be able to control single or multi unit processes by taking into account the formal steps: dynamic process modelling, stability analysis, control structure selection, controller design and implementation by using advanced software (MATLAB) tools . **Contents:** • Process models and dynamics • Feedback control • Enhanced control structures • Decentralized control and Relative Gain Array analysis • Plantwide control
Literature	[1] B. W. Bequette: Process Control, Modeling Design and Simulation, Pearson Education, 2003
Language	English
Forms of teaching	Lecture, Exercise and Project
Requirements for participation	Basic knowledge in control theory or „Systems and Control“
Usability of the module	Compulsory module for the Master Courses ETIT and WETIT with option AT. Compulsory elective module for the Master Course „Electrical Engineering and Information Technology (EEIT)„ and other Study Courses of the OVGU. Compulsory elective module for students of the International Max-Planck Research School.
Examinations prerequisite	Project report
Exam performance	Written exam of 120 minutes (75%), Project report (25%)
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	Dr. Ilknur Disli-Kienle (FEIT-IFAT)

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2.1.9 Seminar Systems Theory and Control Engineering

English title	Seminar Systems Theory and Control Engineering
Qualification goals and contents of the module	**Learning objectives and acquired competences:** Upon completion of the module, students will be able to • conduct advanced mathematical analyses of concepts in systems theory and control engineering and critically assess them, • research, understand, and synthesize scientific literature on a specialized topic, • develop and present proofs, derivations, and theoretical arguments independently, • reflect on and evaluate new methods and models within the broader context of control theory, including underlying assumptions and limitations, as well as • communicate results clearly, engage in professional discussions, and provide constructive peer feedback. **Contents:** The module covers advanced topics in systems theory and control engineering, which change each time the module is taught. The focus is on in-depth discussion and mathematical analysis of already known concepts, for example from nonlinear control theory, and the exploration of new control engineering concepts.
Literature	
Language	German or English
Forms of teaching	Seminar
Requirements for participation	At least one compulsory elective module on control
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and other Master Courses of the FEIT.
Examinations prerequisite	None
Exam performance	Presentation
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 Seminar Autonomous work: consultations and work on the assigned topic
Availability	Every year, either in summer or winter
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Nicole Gehring (FEIT-IFAT)

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2.1.10 State Estimation

English title	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 whether 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 knowledge is deepened in computer exercises. In mini-projects, 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 time-continous 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.
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Basic subjects of the bachelor's degree
Usability of the module	Compulsory elective module for various master's degree programs at the OvGU and for students of the International Max Planck Research School
Examinations prerequisite	None
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, 2 SWS Exercise Autonomous work: Following up on lectures, solving exercises/project tasks, preparing for the 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 Deepening Information and Communication Technology

2.2.1 Automatic Speech Recognition Systems (previously Speech Recognition)

English title	Automatic Speech Recognition Systems
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 and with Large Language Models and Transformer Architectures. • 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, verification. • The participant knows specific requirements and differences in command, dictation and dialogue mode, particularly in the field of applications (e.g. support and dialog systems). **Contents:** • Production and Reception of Natural Speech • Feature Extraction and Classification Techniques • Hidden Markov Models (DTW, Viterbi, Baum-Welch) • Large Language Models and Transformer Architectures • Aspects of robust Speech Recognition: adaptivity, reliability, availabilty, speaker verification • Practical Speech Recognition Systems Design
Literature	
Language	English
Forms of teaching	Lecture, Exercise, Laboratory Internship
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology".
Examinations prerequisite	Mandatory participation in exercise classes, successful results in exercises
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, 1 SWS Exercise, 1 SWS Laboratory Internship Autonomous work: Post processing of lectures, preparation of exercises, Preparation and post processing of internship, 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 Chatbot-Challenge

English title	Chatbot-Challenge
Qualification goals and contents of the module	**Learning objectives and acquired competences:** • Creation of chatbot systems with the Rasa Framework. • Training, evaluation and direct application of AI models of Natural Language Understanding. • Experience in collecting and preparing training data for classification (required amount of data, data balance in different classes). • Creating consistent answers and help texts that contribute to better usability and game design • Evaluation of trained models with regard to their classification performance (suitable measures, cross-validation). • Creation of a chatbot for a selected practical example. • UX user tests (planning, selection of suitable survey tools, implementation and evaluation and derivation of measures for your own chatbot). • Experience with project management and milestone presentations. **Contents:** The task is to develop an escape room game using the AI-supported chatbot framework Rasa. In an escape room, players have to solve a series of puzzles in order to free themselves from a room. The result of the module should be an operable chatbot with a playable and consistent story. This should be proven through user tests. However, the focus here is primarily on the holistic creation of an AI project, from the idea to implementation and evaluation in "productive use". In addition to the pure recognition rate, user experience (UX) and game experience are also important metrics for evaluating the chatbot in the challenge. Not only the generation of the AI model is to be learned, which enables the chatbot to interpret inputs in natural language semantically correctly, but also how the UX of an interactive dialogue system can be evaluated. The study project therefore establishes the extremely relevant link between the creation of an AI-supported system and its use by and impact on users. Within the module, students will present their progress via milestone talks, also in front of external experts, and submit a project report at the end.
Literature	
Language	German/English
Forms of teaching	Lecture, Seminar, Practical Exercises
Requirements for participation	Basic knowledge of Python
Usability of the module	Compulsory elective module for the Master Course “Electrical Engineering and Information Technology” and other FEIT and FIN Master Courses.
Examinations prerequisite	Presentations on the defined milestones, user tests
Exam performance	Presentations at the milestone meetings (4x10%) Written elaboration (project report) (60%)
Credit points and grades	4 SWS / 10 CP = 300 h (56 h time of attendance + 244 h autonomous work) Grading scale as per examination regulations

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Work effort	Time of attendance: 2 SWS Lecture, 2 SWS Seminar Autonomous work: Rework of lectures, working of the seminar task and practical exercises, preparation of the project report
Availability	In the summer semester 2025
Duration of the module	One Semester
Responsible lecturer	Jun.-Prof. Dr.-Ing. Ingo Siegert (FEIT-IIKT)

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2.2.3 Computed Tomography I - Methods on CT

English title	Computed Tomography I - Methods on 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 their interaction with matter. 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 Cone beam • Implementation • Artefacts and Adjustment
Literature	[1] Kak, Slaney: Principles of computerized tomographic imaging; Kalender: Computed Tomography
Language	English
Forms of teaching	Lecture, Tutorial
Requirements for participation	None
Usability of the module	Master Courses in the Faculty of Electrical Engineering and Information Technology, and other Master Courses.
Examinations prerequisite	Tutorial certificate
Exam performance	Written exam 60 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 Tutorial Autonomous work: Rework of lectures and tutorials, preparation of exercises and exam
Availability	Every year in the winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Georg Rose (FEIT-IMT)

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2.2.4 Digital Information Processing Laboratory

English title	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
Language	English
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 attendance at lab sessions and successful submission of all lab assignments
Exam performance	Submission of Lab Assignments + Presentation
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 Seminar, 1 SWS 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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2.2.5 Heterogeneous Computing

English title	Heterogeneous Computing
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The module provides in-depth knowledge of the design, programming, and integration of hardware accelerators such as GPUs, FPGAs, and AI accelerators in CPU-based systems. In addition, application domains of heterogeneous computing systems are discussed and analyzed to determine which types of applications are suitable for which accelerator architectures. Students also learn how software implementations can be adapted and optimized for different hardware platforms. **Contents:** After successfully completing the module, students will be able to • explain the architecture and functionality of various hardware accelerators (GPU, FPGA, AI accelerators), • select suitable accelerators for specific use cases, • design and implement parallel programs for heterogeneous systems, • apply common programming models and frameworks for heterogeneous architectures, • analyze aspects of system integration, in particular memory hierarchies and data movement, • evaluate performance, energy, and scalability aspects of heterogeneous systems. Through theoretical and practical exercises, students deepen their knowledge and apply the concepts they have learned independently.
Literature	
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in electrical engineering or computer science, basic knowledge in C and C++
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 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. Thilo Pionteck (FEIT-IIKT)

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2.2.6 Image Coding

English title	Image Coding
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The objective is to learn the fundamental methods and techniques of image coding as a crucial task in image communication. Image acquisition problems are explained insofar as they are relevant to image coding. Starting from signal/information-theoretical methods, the increasingly significant content-oriented (semantic) techniques are discussed, and applications are explored. Students are enabled to evaluate existing coding methods for still and moving images. They understand relevant problems of image acquisition and representation, know how to estimate the information content of images, master the principles of developing encoders for image and video compression, and are able to apply them in various fields including Medical Imaging. **Contents:** • Representation of pictures • Human perception • Image Acquisition • Information Theory • Quantization • Data compression • Lossy Coding • Video Coding • Transform Coding • Content based and semantic Coding • Standards and applications
Literature	While there is a wealth of literature available on image and video compression, such as John W. Woods' 'Multidimensional Signal, Image, and Video Processing and Coding' (Academic Press, 2012, online), class attendance remains essential. Materials is provided through the e-learning.
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and "Medical Systems Engineering".
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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2.2.7 Seminar Cognitive Systems

English title	Seminar Cognitive Systems
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The student understands the principles of cognitive intelligence and how they are applied in computer programs. He or she is able to apply such programs in practice. **Contents:** This lecture covers the practical application of cognitive intelligent systems. On the one hand, it focuses on their design and organizational structure. From this, theories and artificial representations of human cognition can be derived and tested in practice. Second, the course addresses modeling in spoken and written language as the highest level of representation. This serves as the basis for practical implementation in engineering systems. Third, the course covers practical aspects of meaning assignment and data handling in cognitive systems.
Literature	
Language	English
Forms of teaching	Seminar
Requirements for participation	None
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and other Master Courses of the FEIT.
Examinations prerequisite	None
Exam performance	Written report and presentation of the 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: 3 SWS Seminar Autonomous work: Solving practical exercises, preparing the seminar presentation and 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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2.2.8 Seminar „System-on-Chip“

English title	Seminar „System-on-Chip“
Qualification goals and contents of the module	**Learning objectives and acquired competences:** A system-on-chip (SoC) combines all aspects of a system on a single chip. It is a central component of many mobile computing devices as well as of modern embedded systems. Consequently, the design of SoCs poses many interesting questions, such as the management of heterogeneous processing units, the communication through an on-chip network or the application in critical systems. In this seminar the students work collaboratively to acquire an overview of the state of the art for one of these topics. Through this seminar the students will be able to independently search, understand and classify scientific literature. They will be able to present the acquired knowledge in a systematic way. Furthermore, they get a profound insight on current research topics in the field of system-on-chips. **Contents:** • Overview of a selected research topic connected to SoCs • How to read scientific papers • How to do a systematic literature search • Developing research questions based on the current state of the art
Literature	
Language	English
Forms of teaching	Seminar
Requirements for participation	Participation in the lecture “System on Chip” is recommended.
Usability of the module	Compulsory elective module in the option “Information and Communication Technology” of the master’s programs of the FEIT and further courses of studies at OvGU.
Examinations prerequisite	Active on-site participation in the seminar
Exam performance	Presentation
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 Autonomous work: Reading assignments, preparation of talks
Availability	Every year in the summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Thilo Pionteck (FEIT-IIKT)

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2.2.9 System-on-Chip

English title	System-on-Chip
Qualification goals and contents of the module	**Learning objectives and acquired competences:** A system-on-chip (SoC) is the integration of all components of an electronic system onto a single chip. This module covers the basic structure of SoCs, the hardware architecture of the individual components, and the impact of design decisions on chip design. A key focus of the course is the design of the internal communication network. Upon successful completion of the module, students will have an in-depth understanding of modern SoC architectures. They will be able to analyze and evaluate different architectural approaches in terms of their performance, energy efficiency, scalability, and suitability for specific application areas. Furthermore, they will be able to evaluate communication architectures, compare their characteristics, and select suitable interconnect structures for given system requirements. Students are familiar with the challenges of modern chip integration and can assess their impact on system and communication architecture. They are familiar with current integration and manufacturing technologies and can, in particular, classify 2D, 2.5D, and 3D integration approaches in terms of their technological characteristics, potential, and limitations. In addition, they can analyze heterogeneous chip- and chiplet-based systems and critically evaluate their advantages and disadvantages compared to monolithic SoC architectures. Through theoretical and practical exercises, students are able to deepen their knowledge and skills in a research-oriented manner. The characteristics of different communication architectures are illustrated using simulation tools. **Contents:** • Structure of system-on-chips (SoCs) • On-chip interconnect networks • Network-on-Chips (NoCs) • Photonic NoCs • (Heterogeneous) 3D chips • Design space exploration • Optimization methods
Literature	
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in electrical engineering or computer science, basic knowledge in C and C++
Usability of the module	Compulsory elective module in the Master Course "Electrical Engineering and Information Technology". Compulsory module in other master's degree programs at FEIT.
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, 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. Thilo Pionteck (FEIT-IIKT)

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2.2.10 Theoretical Neuroscience II

English rule	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
Language	English
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 Deepening Micro Systems Engineering

2.3.1 Applications of micro systems engineering

English Title	Applications of micro systems engineering
Qualification goals and contens of the module	**Learning objectives and acquired competences:** Micro systems are increasingly used in electrical mechanical mechanical systems, either enabling new applications or replacing larger, more expensive and energy consuming classical devices. There is a very large variety of different micro systems, ranging from fluidic systems, valves, pumps, droplet generators via optical filters and optical integrated circuits, lidar scanners to micro motors, just to name a few. After having completed at least one of the foundational modules on micro systems engineering as a background, this module will give the students the opportunity to learn more about the actual applications and the complexity of the actual design of micro systems in specific examples. Having completed this module, the students will have profound knowledge in the type of micro systems they have chosen as their topic, and they will be generally able to analyze the application-specific working principles, design aspects and fabrication of micro systems. **Contents:** • The students will choose a topic in conjunction with advice of the lecturer and a suitable distribution of topics in the class • They will be assigned literature for reading and be expected to independently find related literature • The students will present their topic in the class, lead the discussion on their topic and actively participate in the discussion of the topics of other students • The length of the presentations ranging from 30 to 90 minutes and expected volume of the literature will be adjusted to the number of participants to balance the overall workload (more participants = smaller volume, more classroom time, less participants = larger volume, less classroom time) • Milestone meetings will give the students intermediate help and feedback
Literature	To be assigned
Language	English
Forms of teaching	Seminar (If there is a low number of participants that does not provide for regular seminars, the format can be changed.)
Requirements for participation	Prior knowledge in microsystems engineering, i.e. participation in one of the modules "Micromechanics", "Micro Optics" or "Microsystems Processes and Technologies" or a similar course in a previous degree is highly recommended.
Usability of the module	Compulsory elective module in the master's degree program EEIT as well as other master's degree programs of FEIT.
Examinations prerequisite	Participation in the seminars
Exam performance	2/3 presentation, 1/3 written examination (60 minutes)
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 Autonomous work: Literature research, self-study of applications for micromechanics, preparation of presentation

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Availability	Every year in the summer semester
Dauer des Moduls	One Semester
Modulverantwortlicher	Prof. Dr. Matthias Wapler (FEIT-IMT) Further lecturer: Dr.-Ing. Holger Bolze (FEIT-IMT)

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2.3.2 Applied microsystems engineering innovation laboratory

English Title	Applied microsystems engineering innovation laboratory
Qualification goals and contens of the module	**Learning objectives and acquired competences:** The aim of this module is to implement a new innovation in form of a (highly simplified) start-up up to the level of a product demonstrator. The product should be based in its working principle on MEMS components such as MEMS sensors. By completing the module, the students will have gained experience in the complex project coordination and realization of a technological start-up company, and in implementing advanced applications of MEMS components. **Contents:** Prospective students should keep in mind that this is a serious course involving a substantial work load, despite the seemingly short/brief written and oral presentation. The module is designed analogous to the conditions of participation in the VDE COSIMA student competition https://www.cosima-mems.de/ and will be graded similar to the evaluation criteria of the competition. The students work together in groups with up to 4 members and implement their innovative product idea in a simulated start-up project. The group decides upon its internal distribution of duties, the only condition is that it needs to name a speaker. The result of the work is a working demonstrator, some form of marketing (such as social media or a website), a written project portfolio (up to 15 pages including content, team presentation, images, references and appendices) and a pitch presentation (up to 10 minutes). This contains: Product idea, market analysis: • Product demand and target customer groups • Realizability of the business plan • Economic viability Innovation: • Creativity and originality; novelty of the idea. • Technological progress. Does the project use new technologies? • Long-term potential: Can the innovation influence future trends and markets? Implementation of the demonstrator: • Functionality. Does the demonstrator work and demonstrate the core idea? • Technological implementation. Is the implementation robust and thought-through? • Design and user friendliness External communication: • Own internet and social media presentation • (Press communication)* • (Funding: How was the project funded? Which sponsors could be gained?)* Presentation: • Structure and clarity • Visual presentation. (How) is the functioning of the demonstrator presented? Which supporting media are used? • Persuasiveness. Can the team motivate others from their idea? Can they competently answer questions?

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Qualifikationsziele und Inhalte des Moduls	In addition to the presentation pitch the students should prepare a joint one-page document outlining the individual contributions of the team members. * Additional criteria of the COSIMA competition
Literature	
Language	English
Forms of teaching	Independent project work in the laboratory
Requirements for participation	The students should decide on their own, whether they feel qualified. Students who have already taken the "Applied microsystems engineering innovation laboratory - Bachelor" need to demonstrate a significantly different work profile.
Usability of the module	Compulsory elective module in the master's degree program EEIT as well as other degree programs of FEIT.
Examinations prerequisite	None
Exam performance	Presentation consisting of the joint project portfolio and presentation pitch with question-answer session. In addition to the presentation pitch the students should prepare a joint one-page document outlining the individual contributions of the team members. Bachelor and master students of joint projects will be evaluated according to their academic level.
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: 4 SWS Project work in the laboratory Autonomous work: Project organization and implementation
Availability	Flexible. The project is conducted usually during the summer semester. Interested students should contact Prof. Wapler well in advance.
Dauer des Moduls	One Semester
Modulverantwortlicher	Prof. Dr. Matthias Wapler (FEIT-IMT) Further lecturer: Dr.-Ing. Holger Bolze (FEIT-IMT)

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2.3.3 Micro optics

English Title	Micro optics
Qualification goals and contens of the module	**Learning objectives and acquired competences:** After completing this course, the students will have acquired on the one hand a background in optics that is relevant to apply and derive the working principles of micro-optical devices and understand their limitations. On the other hand, they will have a broad overview over the working principles of the most common micro-optical devices. **Contents:** 1. Review of optics • Geometric optics • Wave optics ◦ Diffraction, interference ◦ Fourier optics ◦ Propagation in a wave guide 2. Micro-Optomechatronic devices for imaging and beam shaping • Adaptive lenses • Adaptive mirrors and spatial light modulators • Scanning mirrors • Micro lenses, Shack-Hartmann sensor 3. Micro-optical devices for fiber optics • Fiber optic switches • Ring resonators, whispering gallery resonators • Elements of integrated fiber optics 4. Meta optics • Optical metamaterials, photonic crystals • Diffractive optics, metalenses
Literature	
Language	German/English
Forms of teaching	Lecture, Exercise
Requirements for participation	Engineering mathematics and physics, e.g., bachelor degree in Electrical Engineering, Mechanical Engineering, Physics or related discipline. Basic knowledge of micro mechanics and micro actuators is recommended.
Usability of the module	Compulsory elective module in the master's degree program EEIT as well as other master's degree programs of FEIT.
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, solving and preparation of exercises, preparation of exam
Availability	Every year in the winter semester
Dauer des Moduls	One Semester
Modulverantwortlicher	Prof. Dr. Matthias Wapler (FEIT-IMT)

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2.3.4 Micromechanics

English Title	Micromechanics
Qualification goals and contens of the module	**Learning objectives and acquired competences:** Micromechanics is the core that sets apart micro-electromechanical systems (MEMS) from microelectronics. While the laws of physics on the micro scale are the same as on the macro scale, different effects become relevant, resulting in different engineering concepts. After completing this module, the students are aware of the general mechanical engineering concepts of micro-electromechanical systems and the most common structural and functional components. They are further equipped with the understanding and the tools to quickly estimate the mechanical response such as displacements, forces, flow speeds or resonance frequencies either from the response of building blocks that we derive in classes or from first principles. In combination with the application examples, this puts them in the position to find suitable MEMS solutions based on conventional building blocks and to develop new fundamental working principles. **Contents:** 1. Introduction, comparison of macro and micro scale 2. Solid mechanics • Cantilever springs • Spring systems • Resonances 3. Micro fluidics • Basic fluidic equations, flow profiles, turbulence • Surface tension, capillary effect, droplet generation • Diffusion 4. Micro actuators • Fundamental motivation of principle of least action; Euler-Lagrange equation; principle of virtual work • Electrostatic actuators: Parallel plate, pull-in effect, comb drives, electrowetting, dielectric electroactive polymers; Paschen effect • Magnetic actuators: Lorentz force, voice coil actuators, reluctance actuators • Solid state actuators: Piezo actuators, thermal actuators, bending actuators, 1D and 2D buckling actuators, shape memory materials 5. Application examples and devices • Micro pumps, valves, flow sensor • Smart phone camera • Acceleration sensors, MEMS gyroscopes • Inkjet printer • Other examples TBD
Literature	
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Engineering mathematics and physics, e.g., bachelor degree in Electrical Engineering, Mechanical Engineering, Physics or related discipline.
Usability of the module	Compulsory elective module in the master's degree program EEIT as well as other master's degree programs of FEIT.
Examinations prerequisite	None
Exam performance	Oral test at the end of the module

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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, solving and preparation of exercises, preparation of exam
Availability	Every year in the winter semester
Dauer des Moduls	One Semester
Modulverantwortlicher	Prof. Dr. Matthias Wapler (FEIT-IMT)

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2.3.5 Microsystems Processes and Technologies

English Title	Microsystems Processes and Technologies
Qualification goals and contens of the module	**Learning objectives and acquired competences:** After completing this module, the students are aware of the general fabrication processes of micro systems. They will know the general strategy of how to build a micro system with additive and subtractive processes, the implications on micro systems design and the individual processes and their limitations. They will also have a general understanding of the relevant materials and the characterization techniques. While we will focus on the fabrication of micro electro mechanical systems such as sensors and micro actuators, the concepts are transferable to micro electronics, and we will also briefly cover the relevant nanometer-scale lithography. We will cover both the classical cleanroom-based processes and modern rapid prototyping processes, and in addition, we will cover the most relevant traditional inorganic and modern organic materials and the structural, chemical and dynamic MEMS characterization techniques. **Contents:** 1. Introduction • Why not classical fabrication? Parallel vs. serial processes. Planar systems • Basic MEMS materials, silicon • Clean rooms, yield, wafers 2. Classical micro processes • Lithography: Optical, EUV, multi-patterning, e-beam, x-ray • Subtractive processes: Chemical, physical, (an)isotrophy, selectivity • Additive processes: Surface modification, thin film, thick film, physical, chemical, epitaxy • Back end processes: Bonding, contacting, encapsulation, dicing • Special processes: DRIE, LIGA 3. Modern/rapid prototyping processes • Laser ablation • 2-photon lithography • Surface nano structures • Alternative/organic MEMS materials 4. Characterization techniques • (Electron) microscopy • X-ray Spectrometry, diffractometry • Force microscopy, surface profilometry • Interferometry, vibrometry
Literature	
Language	English
Forms of teaching	Lecture
Requirements for participation	Basic chemistry and physics, e.g., bachelor degree in engineering, natural sciences or related disciplines.
Usability of the module	Compulsory elective module in the master's degree program EEIT as well as other master's degree programs of FEIT.
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

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Work effort	Time of attendance: 3 SWS Lecture Autonomous work: Post processing of lectures, studying of suggested papers and literature, preparation of exam
Availability	Every year in the summer semester
Dauer des Moduls	One Semester
Modulverantwortlicher	Prof. Dr. Matthias Wapler (FEIT-IMT)

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2.4 Deepening Power and Energy

2.4.1 Control of AC Drives (Regelung von Drehstrommaschinen)

English title	Control of AC Drives
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
Language	English
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. Compulsory elective 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

English title	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	
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Knowledge of power system basics
Usability of the module	Compulsory elective 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)

English title	Electromagnetic Compatibility
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
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology" and "Medical System Engineering".
Examinations prerequisite	None
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, 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 summer semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Ralf Vick (FEIT-IMT)

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2.4.4 Model Predictive Control for Three-Phase Converters

English title	Model Predictive Control for Three-Phase Converters

Qualification goals and contents of the module	**Learning objectives and acquired competences:**
	This course covers Model Predictive Control (MPC) techniques for static power converters. Topics include converter topologies, modulation methods, and model predictive control formulation and testing, with applications to electric drives and grid-connected resources. Emphasis is placed on practical implementation through numerical simulations and project-based activities. By the end of the course, the students are expected to:
	• explain the operation of two-level and multilevel three-phase converters,
	• design finite and continuous control set MPC strategies,
	• formulate and solve constrained optimization problems for real-time control of static converters.
	
	Contents:
	• Introduction to Static Converters
	  ◦ Converter topologies and applications; carrier-based and space vector modulation; discrete time modeling and control of static converters.
	• Model Predictive Control principles and implementation
	  ◦ Finite Control Set, FCS, and Continuous Control Set, CCS, model predictive controllers,
	  ◦ Methods to solve constrained optimization problems.
	• Case Studies
	  ◦ FCS and CCS-MPC for grid-connected converters, permanent magnet machines, and multilevel converters.

Literature	[1] Geyer, Tobias: Model predictive control of high power converters and industrial drives; John Wiley & Sons, Ltd, 1st edition; 2017 [2] Rodrigues, Jose et al.; Predictive Control of Power Converters and Electrical Drives, John Wiley & Sons, 1st edition 2012
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies and Master Course "Power Electronics"
Usability of the module	Compulsory elective module for the Master Course "Electrical Engineering and Information Technology".
Examinations prerequisite	None
Exam performance	Written paper and a 15 minutes oral presentation
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, elaboration of the final paper
Availability	Possibly on an annual basis during the summer semester - DeBraIA project.
Duration of the module	One Semester
Responsible lecturer	Prof. Humberto Pinheiro, Ph.D (UFSM - Brazil)

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2.4.5 Photovoltaic Systems

English title	Photovoltaic Systems
Qualification goals and contents of the module	**Learning objectives and acquired competences:** Upon completion of the module, the student will be able to: • to assess available solar resources and their potential for electrical power generation. • to understand the working principles of PV systems, including the solar-electrical energy conversion; • to design PV systems; • to comprehend the main requirements for grid connection and integration to storage systems. **Contents:** • Introduction to photovoltaic (PV) systems • Characterization of solar radiation for PV systems • Solar Cells, Modules and Arrays • Photovoltaic Systems Engineering • Inverters and batteries for PV systems
Literature	Lecture notes, further literature is listed in the lecture notes
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective 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: 1 SWS Lecture, 2 SWS Exercise Autonomous work: Post-processing of lectures, preparation of exercises and exam
Availability	Possibly on an annual basis during the summer semester - DeBraIA project.
Duration of the module	One Semester (block-wise at the end of semester)
Responsible lecturer	Prof. Dr.-Ing. Leandro Michels (UFSM - Brazil)

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2.4.6 Power Electronic Components and Systems

English title	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: The physical approaches underlying power semiconductor devices will be outlined to allow the students to gain a deeper understanding. This applies to the basic theory as well as to the functional principle of different power semiconductor devices which will be derived in the following. In addition the mutual interaction on component and circuit or system level respectively will be considered. This includes aspects of reliability, strengthening the competence for interdisciplinary work by showing cross-links to related fields of engineering. As a result the students shall be capable to design-in suitable power semiconductor components in converters, to theoretically and experimentally evaluate them and to create new designs.
	
	Contents:
	This course refers to active power electronic components and their application:
	• derivation of semiconductor device base equations
	• functional principle, ratings and characteristics of power semiconductor devices:
	  ◦ diode
	  ◦ MOSFET
	  ◦ IGBT
	  ◦ HEMT
	• packaging and assembly
	• dimensioning and reliability

Literature	[1] J. Lutz, H. Schlangenotto, U. Scheuermann, R. de Doncker: Semiconductor Power Devices - Physics, Characteristics, Reliability; Springer-Verlag Berlin - Heidelberg - New York, 2nd edition 2018 [2] Ned Mohan: Power electronics - converters, applications and design; Wiley, Hoboken NJ, 3rd edition 2003
Language	English
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	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 winter semester
Duration of the module	One Semester
Responsible lecturer	Prof. Dr.-Ing. Andreas Lindemann (FEIT-IESY)

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2.4.7 Renewable Energy Sources

English title	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
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective 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 Overarching moduls of the offered deepenings

2.5.1 Basics of Medical Image Science

English title	Basics of Medical Image Science
Qualification goals and contents of the module	**Learning objectives and acquired competences:** The Student will: • get an overview about radiation principles including types of ionizing radiation and their behaviour • learn about the difference between active and passive imaging methods and examples from medical imaging techniques • get to know system theory of medical imaging systems • learn to understand the differences between Fourier-based and task-based image quality descriptions • understand how image quality can be described by different types of observers (human and model observers) **Contents:** • Radiation physics for alpha-, beta-, gamma-, neutron- and X-ray radiation • MTF, NPS and DQE • Ideal observer, human observer models, ROC curves
Literature	provided by e-learning system
Language	English
Forms of teaching	Lecture, Exercise
Requirements for participation	Recommended: Mathematics, Physics, Fundamentals in Electrical Engineering
Usability of the module	Master program
Examinations prerequisite	None
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: Rework of lectures and exercises, preparation of exercises
Availability	Every summer semester (starting from summer term 2022)
Duration of the module	One Semester
Responsible lecturer	Prof. Dr. rer. nat. Christoph Hoeschen (FEIT-IMT)

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2.5.2 Integrated Project

English title	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	
Language	English
Forms of teaching	Scientific project
Requirements for participation	Bachelor in Electrical Engineering or related studies
Usability of the module	Compulsory elective 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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3 Master Thesis

3.1 Master Thesis

English title	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
Language	English
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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