



Description of the degree program

# Electrical Engineering and Information Technology (Bachelor)

## PO 5

Date: 25.02.2026

## Table of contents

### Bachelor Electrical Engineering and Information Technology

#### Mathematics, Fundamentals of Science

Linear Algebra for Electrical Engineering.....	4
Analysis for Electrical Engineering.....	6
Higher Analysis for Electrical Engineering.....	7
Physics for Electrical Engineering with Lab Course.....	8
Optics - Quanta - Materials.....	10
Probability Theory and Statistics.....	12
Mathematical Methods for Electrical Engineering.....	14

#### Fundamentals of Electrical Engineering and Information Technology

Introduction to Electrical Measurement Science with Laboratory.....	16
Fundamentals of Electrical Engineering.....	18
Guided Electromagnetic Waves.....	20
Foundations of Electromagnetic Field Theory.....	22
Basic Circuit Theory.....	24
Signals and Systems.....	26

#### Core Subjects of Electrical Engineering

Fundamentals of Control Engineering.....	28
Fundamentals of Electronics.....	30
Basics of Electrical Power Engineering.....	32
Computer Science for Engineers.....	34
Analog CMOS IC Design.....	36
Fundamentals of Information Technology.....	38
Programming 1.....	40

#### Optional Subjects Autonomous Intelligent Systems

Measurement Electronics.....	42
Measurement Electronics with Experiments.....	44
Identification of Dynamic Systems.....	46
Advanced Control Engineering.....	48
Data Bus Systems.....	50
High-Voltage Safety in the Motor Vehicle.....	52
Automotive Systems Engineering.....	54
Computer Architecture 1.....	56
Computer Architecture Basics and Lab.....	58
Embedded Computing Systems and Lab (2013).....	60
Electromagnetic Compatibility.....	62
Digital Signal Processing.....	64
Fundamentals of Digital Signal Processing.....	66
Electrochemical storages embedded in on-board power systems.....	68
Model Vehicle Design.....	70
Measurement Electronics with Experiments.....	72
Application of Control Engineering Methods.....	74

#### Optional Subjects Information Technologies

Integrated Circuits.....	76
Optical Communications with Lab.....	78
RF and Microwave Systems and Circuits.....	80
Linear photonics with practical course.....	82
Linear Photonics.....	84
Communication Networks for Engineers.....	85
Fundamentals of Communication Networks for engineers.....	87
Electromagnetic Compatibility.....	89
Lab Course for Circuit Design.....	91
Digital Signal Processing.....	93

---

Planning of Terrestrial Radio Networks.....	95
Fundamentals of Digital Signal Processing.....	97
Fundamentals of Mobile Radio Communications.....	99
Digital Signal Transmission.....	101
Mobile Communications.....	103
Hardware Software Systems.....	105
Digital Signal Transmission and Computational Experiments.....	107
<b>Optional Subjects Energy Systems and Drive Technologies/ Powertrain</b>	
Identification of Dynamic Systems.....	109
Advanced Control Engineering.....	111
High-Voltage Safety in the Motor Vehicle.....	113
Electrical Machines and Drives.....	115
Basic Circuits of Power Electronics.....	117
Electromagnetic Compatibility.....	119
Electrical Distribution Systems Technology.....	121
Electrical Transmission Systems Technology.....	123
Energy Economy and Market Integration of Renewables.....	125
Electrochemical storages embedded in on-board power systems.....	127
Design and calculation of DC systems.....	129
<b>Optional Subjects Metrology and Measurement Technology</b>	
Measurement Electronics.....	131
Measurement Electronics with Experiments.....	133
Advanced Control Engineering.....	135
Data Bus Systems.....	137
Lighting Engineering.....	139
Semiconductor Metrology.....	141
Nano- and Bioelectronic System.....	143
Lighting Engineering.....	145
Electromagnetic Compatibility.....	147
Fundamentals of Digital Signal Processing.....	149
Measurement Electronics with Experiments.....	151
<b>Optional Subjects Photonics and Quantum Technologies</b>	
Measurement Electronics.....	153
Measurement Electronics with Experiments.....	155
Integrated Circuits.....	157
Lighting Engineering.....	159
Lighting Engineering.....	161
Molecular Electronics.....	163
Optical Communications with Lab.....	165
Dielectric Materials for Electronics and Photonics.....	167
Linear photonics with practical course.....	169
Linear Photonics.....	171
Electromagnetic Compatibility.....	172
Lab Course for Circuit Design.....	174
Molecular Electronics.....	176
Measurement Electronics with Experiments.....	178
<b>Interdisciplinary Qualification</b>	
Professionalisation.....	180
Industrial Internship.....	182
Team Project.....	184
 Bachelor's Thesis.....	 185

**Mathematics, Fundamentals of Science**

<b>Title</b>	Linear Algebra for Electrical Engineering		
<b>Number</b>	1294010	<b>Module version</b>	
<b>Shorttext</b>	MAT-STD7-0	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 6,0	<b>Module owner</b>	Studiendekan der Mathematik
<b>Workload (h)</b>			
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	96
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>			
<b>Contents</b>			
<b>Objective qualification</b>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• R. Ansorge, H. J. Oberle, K. Rothe, T. Sonar, Mathematik für Ingenieure (2 Bände), Wiley-VCH 2010/2011</li> <li>• K. Meyberg, P. Vachenauer, Höhere Mathematik (2 Bände) Springer 2003/2005</li> <li>• L. Papula, Mathematik für Ingenieure und Naturwissenschaftler – Anwendungsbeispiele, Springer Vieweg 2015</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	4,0	Lecture	german

	2,0	Exercise, small group	german
--	-----	-----------------------	--------

<b>Title</b>	Analysis for Electrical Engineering		
<b>Number</b>	1294020	<b>Module version</b>	
<b>Shorttext</b>	MAT-STD7-02	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 6,0	<b>Module owner</b>	Studiendekan der Mathematik
<b>Workload (h)</b>			
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	96
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>			
<b>Contents</b>			
<b>Objective qualification</b>			
<b>Literature</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	6,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Exercise, small group	german

<b>Title</b>	Higher Analysis for Electrical Engineering		
<b>Number</b>	1294030	<b>Module version</b>	
<b>Shorttext</b>	MAT-STD7-03	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 6,0	<b>Module owner</b>	Studiendekan der Mathematik
<b>Workload (h)</b>			
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	96
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>			
<b>Contents</b>			
<b>Objective qualification</b>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• R. Ansorge, H. J. Oberle, K. Rothe, T. Sonar, Mathematik für Ingenieure (2 Bände), Wiley-VCH 2010/2011</li> <li>• K. Meyberg, P. Vachenauer, Höhere Mathematik (2 Bände) Springer 2003/2005</li> <li>• L. Papula, Mathematik für Ingenieure und Naturwissenschaftler – Anwendungsbeispiele, Springer Vieweg 2015</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	4,0	Lecture	german
	2,0	Exercise, small group	german

<b>Title</b>	Physics for Electrical Engineering with Lab Course		
<b>Number</b>	1511380	<b>Module version</b>	
<b>Shorttext</b>	PHY-IPKM-3	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	Institut für Physik der Kondensierten Materie
<b>Hours per Week / ECTS</b>	9 / 9,0	<b>Module owner</b>	Prof. Dr. Dirk Menzel
<b>Workload (h)</b>	270		
<b>Class attendance (h)</b>	126	<b>Self studying (h)</b>	144
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	written exam (120 min)		
<b>Course achievement</b>	successful participation in lab course		
<b>Contents</b>			
<p>Fundamentals of classical mechanics: inert and gravitational mass, force, acceleration, velocity, trajectories, momentum, elastic and inelastic collisions, rotary motion, torsional moment, angular momentum, angular velocity, moment of inertia;</p> <p>concepts of classical mechanics: Newtonian equations of motion, conservation of momentum, conservation of energy, conservation of angular momentum, harmonic oscillator;</p> <p>separation into classical mechanics, special relativity and quantum mechanics;</p> <p>fundamentals of thermodynamics, laws of thermodynamics, thermodynamic potentials, thermodynamic processes, entropy, ideal and real gases, diffusion, fundamentals of statistical thermodynamics, Maxwell Boltzmann distribution;</p> <p>performance and record of 10 experiments in mechanics, thermodynamics, optics, atomic physics (accompanying the lectures "Physics for Electrical Engineering" and "Optics and Quantum Mechanics"). In a short colloquy it is made sure that the students have the necessary knowledge to perform and record the experiments.</p>			
<b>Objective qualification</b>			
<p>The students are familiar with fundamental physical quantities and concepts of classical mechanics and thermodynamics. They are able to apply the concepts (Newtonian equations of motion, conservation of energy, conservation of angular momentum, conservation of momentum, equation of harmonic oscillator, potentials in thermodynamics, laws of thermodynamics) to different fundamental physical problems and can formulate appropriate solutions.</p> <p>They autonomously perform simple physical experiments and are able to record the results following basic standards of science and technology. They are familiar with the principles of error calculation and are able to specify their results within reasonable error estimation. They can record theory, experimental methods, results, error analysis, and discussion in writing. They are able to present their results graphically in clear and comprehensive charts.</p>			

<b>Literature</b>

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,0	Exercise	german
	4,0	Lecture	german
	2,0	Laboratory	german
	2,0	Laboratory	german

<b>Title</b>	Optics - Quanta - Materials		
<b>Number</b>	2413530	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-53	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	8 / 8,0	<b>Module owner</b>	Prof. Dr. Tobias Voß
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min)		
<b>Course achievement</b>	Two presentations (§ 9 Absatz 7 APO)		
<b>Contents</b>			
<p>geometrical optics                      basic optical instruments                      wave optics                      interference and diffraction                      optical fibers                      lasers                      introduction to Fourier optics                      basic experiments of quantum mechanics (double-slit experiment with electrons, photo effect, Compton effect)                      quantum mechanical states and the Schrödinger equations                      elementary systems in quantum mechanics: particle-in-a-box model, tunnel effect, harmonic oscillator, hydrogen atom                      atoms and atomic binding (covalent, ionic, metallic, van-der-Waals)                      crystalline structure of matter                      metals, dielectrics and semiconductors, superconductors and magnetic materials                      electronic, optical, magnetic and mechanical properties                      semiconductor and metallic nanoparticles                      carbon nanotubes and graphene                      nanotechnology in electronics</p>			
<b>Objective qualification</b>			
<p>The students learn the basic theoretical concepts of ray and wave optics and can analyse and describe the beam path and the propagation of waves in optical instruments. They are familiar with the basic concepts of Fourier optics and can use these concepts for describing optical phenomena. They are familiar with the basic concepts of lasers and optical waveguides, which they can use to describe photonic components. On the basis of the wave-particle duality, students will be able to describe the experiments that led to the development of quantum mechanics. They can describe and mathematically analyze simple quantum mechanical systems with the help of the Schrödinger formalism and can explain the causes and consequences of the quantization of energy states.</p> <p>They acquire knowledge of the atomic structure of matter and are able to describe the fundamental properties of different classes of materials on the basis of the atomic structure of these materials. They describe</p>			

the electro-technically important properties of the different material classes with the relevant basic equations (electrical conductivity, thermal conductivity, diffusion, magnetism, dielectric properties) and use the relevant relationships from thermodynamics and crystallography (phase diagram, energy, entropy and others) for this purpose. Students will be able to explain the special properties of nanostructured materials based on quantum mechanical effects and have an overview of nanostructures relevant in electrical engineering. Students have acquired interdisciplinary qualifications with the help of which they can present independently solved tasks and case studies in the field of "Optics - Quantum - Materials".

**Literature**

#James Shackelford: Werkstofftechnologie für Ingenieure; Pearson 2005 ISBN: 3827371597  
 Paul Tipler: Physik für Wissenschaftler und Ingenieure; Teil 6: Moderne Physik, Struktur der Materie #  
 Ellen Ivers-Tiffée, Waldemar von Münch: Werkstoffe der Elektrotechnik; Teubner 2004 ISBN: 3519301156  
 #  
 Pearson Companion Website: [www.pearson-studium.de](http://www.pearson-studium.de)



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
All courses have to be attended			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Probability Theory and Statistics		
<b>Number</b>	2424470	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-47	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Thomas Kürner
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Introduction</li> <li>• Fundamentals of probability theory</li> <li>• Random variables</li> <li>• Special probability distributions</li> <li>• Functions of random variables</li> <li>• Random processes</li> <li>• Transformation of random processes by systems</li> </ul>			
<b>Objective qualification</b>			
The lecture provides an understanding of the basic methods of statistics and probability theory. After completing the module, students will have knowledge of the mathematical models used to describe random phenomena. They will be able to solve basic problems in the field of statistics independently.			
<b>Literature</b>			
ript # A. Papoulis: Probability, random variables, and stochastic processes, McGraw Hill, 1984 # E. Hänsler: Statistische Signale, Springer-Verlag, 2001 # S. Lipschutz: Wahrscheinlichkeitsrechnung - Theorie und Anwendung, McGraw Hill, 1976 # M. Fisz: Wahrscheinlichkeitsrechnung und mathematische Statistik, VEB Deutscher Verlag der Wissenschaften, 1989 # F. Jondral, A. Wiesler, Wahrscheinlichkeitsrechnung und stochastische Prozesse, Teubner 2002			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			
	2,0	Lecture	german
<b>Literature</b>			
<p>Skript  A.Papoulis: Probability, random variables, and stochastic processes, McGraw Hill, 1984  E.Hänsler: Statistische Signale, Springer Verlag, 2001  S.Lipschutz: Wahrscheinlichkeitsrechnung und mathematische Statistik, VEB Deutscher Verlag der Wissenschaften, 1989  F. Jondral, A. Wiesler: Wahrscheinlichkeitsrechnung und stochastische Prozesse, Teubner 2002</p>			

<b>Title</b>	Mathematical Methods for Electrical Engineering		
<b>Number</b>	2499480	<b>Module version</b>	
<b>Shorttext</b>	ET-STDE-48	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	8 / 8,0	<b>Module owner</b>	Prof. Dr. Michael Kurrat
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	112	<b>Self studying (h)</b>	128
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	homework assignments		
<b>Contents</b>			
<p>On the basis of elementary application examples, the students acquire a descriptive understanding of methods and concepts of engineering mathematics and its references to electrical engineering and information technology. Methods and application examples from the essential areas of the fields taught in the mathematics modules are explained in the lecture and worked on independently by the students in the form of homework and discussed in the small exercise class.</p> <p>The lectures also prepare for parts of the exams Linear Algebra and Analysis for Electrical Engineering.</p> <p>Overview of the essential contents A (application examples in brackets)</p> <ul style="list-style-type: none"> <li>- Equations and inequations with one or several unknowns, treatment of complications such as absolute values or case distinction etc.</li> <li>- Real and complex numbers (calculation of ac circuits problems)</li> <li>- Vector spaces, orthogonality, norm, basis (RMS, power, SNR)</li> <li>- linear transformations and matrices, linear sets of equations, LR and Gauss algorithms (passive linear circuits)</li> <li>- Gram-Schmidt, projections (idea of Fourier series)</li> <li>- Determinants, eigenvalues, eigenvectors, principal axis theorem</li> <li>- Ordinary differential equations, systems of linear 1st order differential equations (transmission line equations, wave equation, resonant LC circuit, harmonic oscillator)</li> </ul> <p>Overview of the essential contents B (application examples in brackets)</p> <ul style="list-style-type: none"> <li>- Nonlinear equations, Newton's method</li> <li>- Sequences and series</li> <li>- Continuous and differentiable functions of one real argument, extrema (power matching)</li> <li>- Integration, fundamental theorem of calculus</li> <li>- Taylor series, Fourier series</li> <li>- Differentiable functions of more than one variable, partial derivatives</li> <li>- Extrema, optimization subject to equality constraints</li> <li>- Curves and surfaces in space, vector fields, basic concepts of vector analysis (electromagnetic fields)</li> <li>- Integration (line/surface/volume integrals), coordinate transformations</li> <li>- Integral invariants and transformations: Gauss/divergence theorem, Stokes theorem, Green's identities</li> </ul>			

**Objective qualification**

Students acquire a descriptive understanding of mathematics as a fundamental tool in electrical engineering and information technology  
 (1) as means of abstract description of physical and technical concepts and relations  
 (2) as a tool for modeling and analysis of physical-technical structures and systems  
 (3) as a method for manipulation of signals and other entities that are represented numerically.  
 Hence, students understand how mathematical concepts and methods are applied and recognize which methods are suitable for modeling and solution of physical, technical or information-technological problems. To form a basis for the methodical understanding, students improve their numeracy skills. They command fundamental mathematical methods and know how to apply these on electrical and information-theoretical problems. In the field of numerical computation students have a basic understanding of exemplary numerical methods.

**Literature**

R. Ansorge, H. J. Oberle, K. Rothe, T. Sonar, Mathematik für Ingenieure (2 Bände), Wiley-VCH 2010/2011  
 K. Meyberg, P. Vachenauer, Höhere Mathematik (2 Bände) Springer 2003/2005  
 L. Papula, Mathematik für Ingenieure und Naturwissenschaftler – #Anwendungsbeispiele, Springer Vieweg 2015



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
	2,0	Exercise, small group	german
	2,0	Lecture	german
	2,0	Exercise, small group	german

**Fundamentals of Electrical Engineering and Information Technology**

<b>Title</b>	Introduction to Electrical Measurement Science with Laboratory		
<b>Number</b>	2411320	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-32	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	5 / 7,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	210		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	140
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min)		
<b>Course achievement</b>	Successful participation in lab course		
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Basic terms, units</li> <li>- Measurement deviations (error calculation)</li> <li>- Measurement uncertainty and noise</li> <li>- Measuring chain</li> <li>- Sensors for non-electrical quantities</li> <li>- Measuring transducer and bridge circuit</li> <li>- Basic operational amplifier circuit</li> <li>- Analogue/digital signal representation</li> <li>- Analogue-to-digital converter</li> <li>- Digital measuring equipment</li> <li>- Laboratory experiments</li> </ul>			
<b>Objective qualification</b>			
<p>Nach Abschluss des Moduls "Grundlagen der Elektrischen Messtechnik" verfügen die Studierenden über eine grundlegende Übersicht über die Messkette, die Fehler bei einer Messung, den Einsatz und die Dimensionierung elektrischer Sensoren für nichtelektrische Größen und die wichtigsten Messgeräte. Diese Grundlagen ermöglichen die Nutzung, den Entwurf und die Fehlerbeurteilung moderner Messsysteme. Das Labor ermöglicht zusätzlich praktische Kenntnisse bei der Nutzung von Messsystemen.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Skript auf CD - E.Schrüfer, "Elektrische Messtechnik", HanserVerlag, 29.90 Euro, ISBN 978-3446409040</li> <li>- A. Schöne, "Messtechnik", Springer Verlag, ISBN 978-3540600954</li> <li>- N. Weichert, "Messtechnik und Messdatenerfassung", Oldenbourg Verlag ISBN 978-3486251029</li> <li>- H. Frohne/E. Ueckert "Grundlagen der elektrischen Messtechnik", Teubner Verlag, ISBN 978-3519064060</li> <li>- R. Patzelt, H. Schweinzer, "Elektrische Messtechnik", Springer Verlag</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>			
	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• E. Schrüfer, #Elektrische Messtechnik#, HanserVerlag #</li> <li>• A. Schöne, #Messtechnik#, Springer Verlag #</li> <li>• N. Weichert #Messtechnik und Messdatenerfassung#, Oldenbourg Verlag #</li> <li>• H. Frohne/E. Ueckert #Grundlagen der elektrischen Messtechnik#, Teubner Verlag #</li> <li>• R. Patzelt, H. Schweinzer, #Elektrische Messtechnik#, Springer Verlag</li> </ul>			
	1,0	Exercise	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• E. Schrüfer, #Elektrische Messtechnik#, HanserVerlag #</li> <li>• A. Schöne, #Messtechnik#, Springer Verlag #</li> <li>• N. Weichert #Messtechnik und Messdatenerfassung#, Oldenbourg Verlag #</li> <li>• H. Frohne/E. Ueckert #Grundlagen der elektrischen Messtechnik#, Teubner Verlag #</li> <li>• R. Patzelt, H. Schweinzer, #Elektrische Messtechnik#, Springer Verlag</li> </ul>			
	3,0	Laboratory	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Skript D. Huhnke #</li> <li>• E. Schrüfer, #Elektrische Messtechnik#, HanserVerlag #</li> <li>• A. Schöne, #Messtechnik#, Springer Verlag #</li> <li>• N. Weichert #Messtechnik und Messdatenerfassung#, Oldenbourg Verlag #</li> <li>• H. Frohne/E. Ueckert #Grundlagen der elektrischen Messtechnik#, Teubner Verlag #</li> <li>• R. Patzelt, H. Schweinzer, #Elektrische Messtechnik#, Springer Verlag</li> </ul>			

<b>Title</b>	Fundamentals of Electrical Engineering		
<b>Number</b>	2412610	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-61	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	13 / 13,0	<b>Module owner</b>	Prof. Dr. Michael Terörde
<b>Workload (h)</b>	390		
<b>Class attendance (h)</b>	182	<b>Self studying (h)</b>	208
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (180 min)		
<b>Course achievement</b>	Labwork. Homework (§ 4, 14 BPO), will be specified in the first lectures.		
<b>Contents</b>			
Physics of the electron, electric field, movement of charge field, electrical networks, magnetic field, induction, alternating current, impedance, complex pointers, frequency responses, switching operations.			
<b>Objective qualification</b>			
After completing the module, the students are familiar with the basic assumptions of field-theoretical modeling and the Maxwell equations in integral form. They are able to quantitatively analyze simple field-theoretical problems using symmetries. Based on the fundamental concepts of current, voltage, resistance, capacitance, and inductance, they are able to derive simple equivalent circuits for selected field-theoretical problems. They can analyze simple networks using Kirchhoff's node and mesh equations. They are familiar with constant and periodic stimulations and with switching operations in networks. They can investigate switching processes in networks quantitatively using differential equations. They are able to analyze networks with periodic stimulations in the time domain or using phasors. They can determine amplitude and phase responses for simple networks.			
<b>Literature</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	3,0	Internship	german
<b>Literature</b>			
Praktikumskript			
Paul, R.: Elektrotechnik 1 und 2 Springer Verlag, 3. Auflage 1993			
Pregla, R.: Grundlagen der Elektrotechnik I und II, Hüthig Verlag, 5. Auflage 1998			
Wolff, I.: Grundlagen der Elektrotechnik, Verlagshaus Nellissen-Wolff 1997			
Moeller et. al.: Grundlagen der Elektrotechnik, 18. Auflage, Teubner Verlag 1996			
Formelsammlung:			
Kories, Schmidt-Walter: Taschenbuch der Elektrotechnik 3. Auflage, Verlag Harri Deutsch 1998			
	2,0	Lecture	german
	2,0	Exercise	german
	1,0	Seminar	german
	2,0	Exercise	german
	1,0	Seminar	german
	2,0	Lecture	german

<b>Title</b>	Guided Electromagnetic Waves		
<b>Number</b>	2415210	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-21	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Wolfgang Kowalsky
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (150 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Differential equations of electromagnetic leads and solutions in the steady state</li> <li>- Impedance transformation, Smith diagram</li> <li>- Propagation coefficients of leads</li> <li>- Equivalent circuits, lattice networks and periodic structures</li> <li>- Transients and pulses on leads</li> <li>- Multiple circuit lines</li> </ul>			
<b>Objective qualification</b>			
After completion of the module students have deeper understanding of guidance of electromagnetic waves on leads. They are able to design and dimension lead systems.			
<b>Literature</b>			
Unger, Elektromagnetische Wellen auf Leitungen, ELTEX Studentexte Elektrotechnik, Hüthig, ISBN 3778523902			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Lecture	german
<b>Literature</b>			
H.-G. Unger, Elektromagnetische Wellen auf Leitungen, ELTEX Studentexte Elektrotechnik			
	2,0	Exercise	german

<b>Title</b>	Foundations of Electromagnetic Field Theory		
<b>Number</b>	2419100	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-10	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Jörg Schöbel
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Introduction into the classical electromagnetic field theory:</p> <ul style="list-style-type: none"> <li>• physical basic principles</li> <li>• transition from the Coulomb and Biot-Savart-Ampere force equations to the differential formulation</li> <li>• Faraday law of induction</li> <li>• Maxwell's displacement current</li> <li>• Maxwell equations</li> <li>• Plane waves as solutions of the homogeneous wave equation</li> <li>• Fresnel equations</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to present and explain the foundations of the electromagnetic field theory. They can distinguish between integral and local conceptions and they can justify the more general meaning of the local approach by partial differential equations. They understand the assumptions for simplifications of equations and can decide whether they are met for a given problem. They can calculate force fields for given source distributions. They can describe the reaction of material in the electromagnetic field and derive the extension of the microscopic to the macroscopic Maxwell equations. They can apply the Maxwell equations in material and at boundaries. They can analyze and calculate the propagation of plane waves and their interaction with material for basic geometries. They can choose and apply solution approaches for elementary problems.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Lecture notes</li> <li>• Günther Lehner, Elektromagnetische Feldtheorie für Ingenieure und Physiker, Springer-Verlag Berlin, 2008, ISBN 978-3-540-77681-9 #</li> <li>• Karl Kupfmüller, Theoretische Elektrotechnik und Elektronik, Springer-Verlag, Berlin, 2000, ISBN 3-540-67794-1</li> <li>• Karoly Simonyi, Theoretische Elektrotechnik, Johann Ambrosius Barth, Leipzig, 1993, ISBN 3-335-00375-6 #</li> <li>• David J. Griffiths, Introduction to Electrodynamics, Prentice Hall, New Jersey, 1999, ISBN 0-13-919960-8</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Basic Circuit Theory		
<b>Number</b>	2420180	<b>Module version</b>	
<b>Shorttext</b>	ET-BST-20	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für CMOS Design
<b>Hours per Week / ECTS</b>	7 / 8,0	<b>Module owner</b>	Prof. Dr. Vadim Issakov
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	98	<b>Self studying (h)</b>	142
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Exam+, 150 min		
<b>Course achievement</b>	Homework assignments (according to APO § 9), details will be specified in the first lectures. Upon request, the result of the course achievement can be accounted for the written exam+ to 15 %.		
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Kirchhoff's laws</li> <li>- Systematic determination of linearly independent mesh and intersection equations by using graph theory</li> <li>- Linear time-invariant circuit models with ideal switches</li> <li>- Motivation and formulation of the answer of a general, linear, time-invariant circuit model</li> <li>- Asymptotic stability, representation of the response in steady state</li> <li>- Harmonic steady state and frequency response</li> <li>- Response from the steady state</li> <li>- Determination of the responses in the steady state and from the resting state using the frequency response</li> <li>- Convolution product and system behavior</li> <li>- Linear algebraic network equation systems</li> <li>- Tableau of the circuit equations</li> <li>- Intersection admittance, nodal admittance and mesh impedance methods</li> <li>- Source displacement</li> <li>- Modified Nodal Approach</li> <li>- Small-signal analysis of non-linear, time-invariant circuits</li> <li>- Operational amplifiers</li> </ul>			
<b>Objective qualification</b>			
Students acquire knowledge of circuit analysis methods based on frequency responses. Furthermore, the system behavior of circuits is examined. After completing this module, they will be able to calculate the temporal behavior of linear, time-invariant circuits in many relevant aspects.			
<b>Literature</b>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	3,0	Lecture	german
	2,0	Exercise	german
	2,0	Exercise, small group	german

<b>Title</b>	Signals and Systems		
<b>Number</b>	2424640	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-64	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	4 / 6,0	<b>Module owner</b>	Prof. Dr. Eduard Jorswieck
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	124
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Signal description in time domain            Signal operation and special signals            Elementary, static, and dynamic systems            Linear time-continuous systems            Non-linear time-continuous systems            Signal description in frequency domain            System description in time domain            System properties: stability, invertibility, causality            Fourier transform, Fourierintegral, Laplace transform, Laplaceintegral, inverse Laplace transform            Relation time and frequency domain, realization            Stationary and volatile process            Frequency characteristics            Bode diagrams            System properties: Classification            Stability, all-pass filter, minimum phase system            Hilbert transform</p>			
<b>Objective qualification</b>			
<p>The students know the basic, ordering meaning of the concept of systems in engineering. They understand the general approach of system theory as well as applications to analog continues-time systems. They master the application of signal transformations (Fourier, Laplace) for effective description of the system behaviour in frequency domain. In particular, they are able to apply the system theoretic way of thinking to important sub-areas of their field of study, for example to the computation of electoral networks with non-sinusoidal excitation.</p>			
<b>Literature</b>			
<p>#Wunsch, G. ; Schreiber, H.: "Analoge Systeme", 4. Auflage, TUDpress Verlag der Wissenschaften GmbH, 2006. # ISBN 10: 3938863676 #Oppenheim, A. von ; Willsky, A.: "Signals &amp; Systems", 2. Auflage, Pearson, 1996, ISBN 10: 0138147574            Ohm, J. ; Lüke, H.-D.: "Signalübertragung", 12. Auflage, Springer, 2014, ISBN 978-3-642-53901-5            Haykin, S. : "Signals and Systems", 2. Auflage, John Wiley &amp; Sons, 2003, ISBN-10: 0471378518</p>			

Kreß, D. ; Kaufhold, B.: "Signale und Systeme verstehen und vertiefen - Denken und Arbeiten im Zeit- und Frequenzbereich", Vieweg+Teubner Verlag / Springer Fachmedien Wiesbaden GmbH, 2010, ISBN-10: 3834810193



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<p>? Wunsch, G. ; Schreiber, H.: "Analoge Systeme", 4. Auflage, TUDpress Verlag der Wissenschaften GmbH, 2006. ? ISBN 10: 3938863676 ? Oppenheim, A. von ; Willsky, A.: "Signals &amp; Systems", 2. Auflage, Pearson, 1996, ISBN 10: 0138147574 ? Ohm, J. ; Lüke, H.-D.: "Signalübertragung", 12. Auflage, Springer, 2014, ISBN 978-3-642-53901-5 ? Haykin, S. : "Signals and Systems", 2. Auflage, John Wiley &amp; Sons, 2003, ISBN-10: 0471378518 ? Kreß, D. ; Kaufhold, B. : "Signale und Systeme verstehen und vertiefen - Denken und Arbeiten im Zeit- und Frequenzbereich", Vieweg+Teubner Verlag / Springer Fachmedien Wiesbaden GmbH, 2010, ISBN-10: 3834810193</p>			
	2,0	Exercise	german
<b>Literature</b>			
<p>? Wunsch, G. ; Schreiber, H.: "Analoge Systeme", 4. Auflage, TUDpress Verlag der Wissenschaften GmbH, 2006. ? ISBN 10: 3938863676 ? Oppenheim, A. von ; Willsky, A.: "Signals &amp; Systems", 2. Auflage, Pearson, 1996, ISBN 10: 0138147574 ? Ohm, J. ; Lüke, H.-D.: "Signalübertragung", 12. Auflage, Springer, 2014, ISBN 978-3-642-53901-5 ? Haykin, S. : "Signals and Systems", 2. Auflage, John Wiley &amp; Sons, 2003, ISBN-10: 0471378518 ? Kreß, D. ; Kaufhold, B. : "Signale und Systeme verstehen und vertiefen - Denken und Arbeiten im Zeit- und Frequenzbereich", Vieweg+Teubner Verlag / Springer Fachmedien Wiesbaden GmbH, 2010, ISBN-10: 3834810193</p>			

<b>Core Subjects of Electrical Engineering</b>
--

<b>Title</b>	Fundamentals of Control Engineering		
<b>Number</b>	2412600	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-60	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min)		
<b>Course achievement</b>			
<b>Contents</b>			
Basics, block diagram, modeling of dynamic systems with concentrated elements, differential equations, linearization, frequency range, frequency response, Nyquist diagram, Bode diagram, typical individual elements of controlled systems, transfer function, control loop, stability, controller design, equivalent time constant, root locus method, cascade control, use of microcomputers, discrete-time control systems, difference equations, z-transform, digital signal processing, filters, bilinear transform, compensation controller, dead beat controller			
<b>Objective qualification</b>			
After completing the module, the students have basic knowledge in the field of linear control engineering. They know the properties and dynamic behavior of basic control engineering components and standard controllers. Students will be able to describe the basic features of digital signal processing and explain the operation of a digital control system. They understand the concepts for the description of linear as well as simple nonlinear dynamic systems in the time domain and in the frequency domain as well as the concept of Laplace and Z-transformation. They can model linear time-invariant systems with lumped memories and design controllers in the frequency domain. This includes the design by means of pole placement, the method of equivalent time constants, as well as working in the Bode diagram and the design of discrete-time controllers. Furthermore, the students are able to analyze the stability of closed control loops and to evaluate their quality.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- J. Lunze: Regelungstechnik 1 &amp; 2, Springer-Verlag, ISBN: 978-3540689072 &amp; 978-3540784623</li> <li>- R. Unbehauen: Regelungstechnik 1 &amp; 2, Vieweg-Verlag, ISBN: 978-3834804976 &amp; 978-3528833480</li> <li>- O. Föllinger: Regelungstechnik, Hüthig-Verlag, ISBN: 978-3778529706</li> <li>- W. Leonhard: Einführung in die Regelungstechnik, Vieweg-Verlag, ISBN: 978-3528535841</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	3,0	Lecture	german
	1,0	Exercise	german

<b>Title</b>	Fundamentals of Electronics		
<b>Number</b>	2413500	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-50	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Andreas Waag
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (150 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Electronic properties of semiconductors</li> <li>• Diode</li> <li>• FET</li> <li>• Bipolar transistors</li> <li>• Circuit technology</li> <li>• Digital electronics</li> <li>• Optoelectrical components</li> <li>• Integrated circuits and semiconductor technological processes</li> </ul>			
<b>Objective qualification</b>			
<p>Students will be able to calculate and explain the principles, modes of operation and electrical properties of important semiconductor components (diodes, bipolar transistors, thyristors and field-effect transistors) and plan their use in simple analogue and digital basic circuits. This subject area also includes a description of the nature of charge transport in semiconductors and its physical principles. To this end, the students solve differential equations to describe local field strength, band edge and charge carrier concentration curves and calculate the resulting current transport. As a result, they obtain characteristic curves of important semiconductor components. The functionalities and areas of application of optoelectronic components such as light-emitting diodes, lasers, photodetectors and solar cells can be described in detail. Students will also be able to grasp the physical principles of optoelectronic components and describe their significance for applications. They can confidently describe the basic physical concepts for describing the electrical and optical properties of semiconductors on the basis of crystal and band structures and the quantities derived from them. They can also reproduce basic concepts of CMOS design and describe key technological processes. They will be able to analyse the small-signal behaviour of simple analogue amplifier circuits.</p>			
<b>Literature</b>			
# A. Schlachetzki: "Halbleiter-Elektronik", Teubner Studienbücher, B.G. Teubner, Stuttgart, 1990 ISBN: 3-519-03070-5			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	3,0	Lecture	german
<b>Literature</b>			
A. Schlachetzki: "Halbleiter-Elektronik", Teubner Studienbücher, B.G. Teubner, Stuttgart, 1990			
	1,0	Exercise	german
<b>Literature</b>			
Übungsskript (Aufgaben mit Lösungen) zum Herunterladen			

<b>Title</b>	Basics of Electrical Power Engineering		
<b>Number</b>	2414320	<b>Module version</b>	
<b>Shorttext</b>	ET-IMAB-32	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Maschinen, Antriebe und Bahnen
<b>Hours per Week / ECTS</b>	6 / 6,0	<b>Module owner</b>	Prof. Dr. Markus Henke
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	96
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (180 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Part 1:</p> <ul style="list-style-type: none"> <li>- Fundamentals of energy supply</li> <li>- Fundamentals of electrical power transmission</li> <li>- High-voltage three-phase current transmission, three-phase current systems, three-phase current transformers, synchronous generators, overhead lines and cables</li> <li>- Power plant control</li> <li>- Faults in three-phase networks</li> <li>- High-voltage direct current transmission</li> <li>- Fundamentals of the electrical energy industry</li> <li>- Primary and secondary energies</li> <li>- Electrical energy generation, thermodynamic principles. Joule process, Clausius-Rankine process</li> <li>- Gas turbine power plant, steam power plant, combined cycle power plants</li> <li>- Basics of high voltage technology</li> <li>- Voltage stresses in the grid, insulation coordination</li> <li>- Electrical strength, calculation of electrical fields, utilisation factor according to Schwaiger</li> <li>- Breakdown voltage, breakdown field strength</li> <li>- Protective measures, personal protection in low-voltage systems</li> </ul> <p>Part 2:</p> <ul style="list-style-type: none"> <li>- Fundamentals of electromechanical energy conversion</li> <li>- Forces in magnetic circuits</li> <li>- Function and description (equivalent circuit diagrams) of the basic types of electrical machines</li> <li>- Operating behaviour of direct current machines</li> <li>- Rotating and travelling fields, mathematical description</li> <li>- Synchronous machine</li> <li>- Asynchronous machine</li> </ul> <p>Part 3:</p> <ul style="list-style-type: none"> <li>- Fundamentals of power electronics</li> <li>- Components of power electronics</li> </ul>			

- Power semiconductors and their applications
- Basic power converter circuits
- Network perturbations
- Reactive power
- Inverter basics

**Objective qualification**

After completing this part of the module, students will be able to

Part 1:

- understand and apply basic knowledge of equivalent circuits of operating equipment
- apply complex calculations in three-phase networks for operating and short-circuit cases
- apply the mathematical relationships to specific tasks

Part 2:

- understand the basic modes of operation of electromagnetic converters (electrical machines)
- analyse and interpret the equations describing the basic operating behaviour of direct current, asynchronous machines and synchronous machines apply the mathematical relationships to specific tasks

Part 3:

- derive from the structure of power semiconductor switches commonly used today their mode of operation and electrical behaviour
- understand the mode of operation of basic power converter circuits from the group of rectifiers, direct current controllers, inverters and converters and name application examples
- analyse and mathematically describe the relationship between input and output variables of these basic circuits

**Literature**



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

	4,0	Lecture	german
--	-----	---------	--------

**Literature**

Teil 1: Grundlagen der Energieversorgung Elektrische Energieversorgung, K. Heuck, Vieweg Verlag Elektrische Energieverteilung, R. Flosdorff, Teubner Verlag Teil 2: Grundlagen der elektromechanischen Energieumformung R. Fischer, Elektrische Maschinen, Hanser Binder, Elektrische Maschinen und Antriebe: Grundlagen, Betriebsverhalten, Springer Teil 3: Grundlagen der Leistungselektronik Leistungselektronik - Grundlagen und Anwendung, R. Jäger, E. Stein, VDE-Verlag Grundkurs Leistungselektronik, Joachim Spe-covius, Vieweg-Verlag

	2,0	Exercise	german
--	-----	----------	--------

<b>Title</b>	Computer Science for Engineers		
<b>Number</b>	2416740	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-74	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	5 / 6,0	<b>Module owner</b>	Prof. Dr. Andres Gomez
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	110
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min) or oral exam (30 min)		
<b>Course achievement</b>	Successful participation in lab course		
<b>Contents</b>			
Hardware and software, logical circuits, digital switching networks (Boolean algebra), circuit technology (microelectronics), switching units, control units, memory, structure and mode of operation of digital computers (microprocessors), input and output devices, system software.			
<b>Objective qualification</b>			
The students have knowledge of the architecture and basic mode of operation of modern computers. In addition, students will be able to design digital logic circuits using common development tools and programme computers in high-level language using the example of embedded systems.			
<b>Literature</b>			
Mano, Kime, Logic and Computer Design Fundamentals, 4. Ausgabe, Pearson Flik, Mikroprozessortechnik, Springer Herold, Lurz, Wohlrab, Grundlagen der Informatik, Pearson			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german

	1,0	Internship	german
	2,0	Exercise	german

<b>Title</b>	Analog CMOS IC Design		
<b>Number</b>	2420160	<b>Module version</b>	
<b>Shorttext</b>	ET-BST-16	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für CMOS Design
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Vadim Issakov
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (150 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>he most important basic circuits of CMOS technology are introduced and explained and important design criteria for these circuits are developed. Among others, the following circuits are covered:</p> <ul style="list-style-type: none"> <li>- source, gate, and drain circuits with active and passive loads</li> <li>- MOS cascode circuits</li> <li>- differential amplifier circuits</li> <li>- current mirror circuits</li> <li>- voltage and current reference circuits</li> <li>- elementary operational amplifier circuits</li> </ul> <p>In addition to the elementary stability analysis of amplifier circuits, the operating point determination (DC analysis) is covered, the small-signal behavior (AC analysis) and, in extracts, the transient large-signal behavior (transient analysis) of the circuits.</p>			
<b>Objective qualification</b>			
After completing the module, students will be familiar with the basic elements and circuit components of CMOS technology and their basic circuit technology. They are familiar with the design of elementary integrated CMOS circuits.			
<b>Literature</b>			
B. Razavi: "Design of Analog Integrated Circuits" McGraw-Hill A.S.Sedra, K.C. Smith: "Microelectronic Circuits" Oxford University Press			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Fundamentals of Information Technology		
<b>Number</b>	2424610	<b>Module version</b>	V2
<b>Shorttext</b>	ET-NT-61	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	5 / 6,0	<b>Module owner</b>	Prof. Dr. Eduard Jorswieck
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	96
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam 120 min – 3 parts à 40 min		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Physical principles of communication:</p> <ul style="list-style-type: none"> <li>- The electromagnetic wave</li> <li>- The wireless channel</li> <li>- Antennas</li> <li>- Propagation of e/m waves</li> <li>- Calculation of radio links</li> <li>- THz communication</li> <li>- Radio systems</li> <li>- Optical communication</li> <li>- Silicon Photonics</li> <li>- Plasmonics</li> </ul> <p>Communications Engineering:</p> <ul style="list-style-type: none"> <li>- Basic terms and concepts of communications engineering</li> <li>- History of communications engineering</li> <li>- Models, contents and media of communications engineering</li> <li>- Source and source coding</li> <li>- Signals, systems, modulation methods</li> <li>- Transmission channels</li> <li>- Decision theory</li> <li>- Channel coding</li> </ul> <p>Communication networks:</p> <ul style="list-style-type: none"> <li>- Data Link Layer: Ethernet</li> <li>- Network Layer: Store and Forward</li> <li>- Network Layer: Delay, Loss, and Throughput</li> <li>- Network Layer: Routing Protocols and Algorithms</li> <li>- Transport layer: TCP and UDP baselines, new transport protocols</li> </ul>			

- Performance evaluation: theoretical and practical methods
- Network Security: Fundamentals of Cryptography

**Objective qualification**

Students will be able to name the basic concepts of information technology and divide them into the fundamentals of communications engineering, communications networks and communications and their underlying physical principles. Students are able to distinguish the three areas from each other, to grasp their connections, dependencies and interactions, and to classify important tasks in information technology research and development. They know and understand basic models of modern communication systems and networks on the technological layers (physical, transmission, multiple access and network layers) and can construct new models for future technologies. In addition, they are able to assess which theoretical aspects of information technology need to be addressed to advance research in the field.

**Literature**

1. J. G. Proakis, M. Salehi, Grundlagen der Kommunikationstechnik, Pearson Studium, 2. Auflage, 2004.
2. M. Bossert, Einführung in die Nachrichtentechnik, Oldenbourg Verlag, 2012.
3. A. F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G (Wiley - IEEE)
4. P. P. Sahu, Fundamentals of Optical Networks and Components
5. Deep Medhi and Karthik Ramasamy. Network Routing - Algorithms, Protocols, and Architectures (2nd ed.). Morgan Kaufmann.
6. James F. Kurose and Keith Ross. Computer Networking: A Top-Down Approach (8th ed.). Pearson.
7. Dimitri Bertsekas und Bob Gallager. Data Networks, Second Edition, Prentice Hall.



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Foliensatz zur VL			
	1,0	Lecture	german
	1,0	Lecture	german
	2,0	Lecture	german
<b>Literature</b>			
- Skript - Vorlesungsbegleitendes Multimedia-Lernprogramm (CD) - Martin Werner: Nachrichtentechnik, Reihe: Studium Technik, Vieweg+Teubner Verlag, ISBN 3-8348-0456-8, 2009			

<b>Title</b>	Programming 1		
<b>Number</b>	4210430	<b>Module version</b>	V2
<b>Shorttext</b>	INF-ROB-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	Institut für Betriebssysteme und Rechnerverbund
<b>Hours per Week / ECTS</b>	4 / 6,0	<b>Module owner</b>	Prof. Dr. Martin Johns
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	124
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	1 graded work: Written exam (120 minutes) or Take-Home-Exam.		
<b>Course achievement</b>	1 Coursework: Successful completion of homework assignments		
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Fundamentals of imperative and object-oriented programming using the Java language</li> <li>- Recursive methods</li> <li>- Reliability of programmes</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students will have a basic understanding of imperative and object-oriented programming as well as the Java language. They will be able to develop small programmes independently.			
<b>Literature</b>			
R. Sedgewick, K. Wayne: Einführung in die Programmierung mit Java. 1. Auflage. Pearson-Verlag, München 2011.			
D. Ratz, J.Scheffler: Grundkurs Programmieren in Java. 6. aktualisierte und erweiterte Auflage. Hanser Verlag, München, Wien 2011.			
R. Schiedermeier: Programmieren mit Java. 2. aktualisierte Auflage. Pearson Studium, München 2010.			
W. Struckmann, D. Wätjen: Mathematik für Informatiker. Spektrum Akademischer Verlag, 2007.			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
The lecture and the small exercise are compulsory. The exercise is optional.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Programming 1	2,0	Lecture	german
<b>Literature</b>			
R. Sedgewick, K. Wayne: Einführung in die Programmierung mit Java. 1. Auflage. Pearson-Verlag, München 2011. D. Ratz, J.Scheffler: Grundkurs Programmieren in Java. 6. aktualisierte und erweiterte Auflage. Hanser Verlag, München, Wien 2011. R. Schiedermeier: Programmieren mit Java. 2. aktualisierte Auflage. Pearson Studium, München 2010. W. Struckmann, D. Wätjen: Mathematik für Informatiker. Spektrum Akademischer Verlag, 2007.			
	2,0	Exercise	german
Programming 1	2,0	Exercise, small group	german
<b>Literature</b>			
R. Sedgewick, K. Wayne: Einführung in die Programmierung mit Java. 1. Auflage. Pearson-Verlag, München 2011. D. Ratz, J.Scheffler: Grundkurs Programmieren in Java. 6. aktualisierte und erweiterte Auflage. Hanser Verlag, München, Wien 2011. R. Schiedermeier: Programmieren mit Java. 2. aktualisierte Auflage. Pearson Studium, München 2010. W. Struckmann, D. Wätjen: Mathematik für Informatiker. Spektrum Akademischer Verlag, 2007.			

**Optional Subjects Autonomous Intelligent Systems**

Optional Subjects Autonomous Intelligent Systems			
<b>Title</b>	Measurement Electronics		
<b>Number</b>	2411230	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-23	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	78
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Measuring amplifiers with transistors and OPVs Electronic switches Source circuits Measuring transducers Analogue filter circuits Treatment of interference signals and noise Correlation analysis Measurement converters (A/D and D/A) Measuring device buses Time measurement Oscilloscopes and trigger circuits			
<b>Objective qualification</b>			
After completing the 'Measurement Electronics' module, students will have an overview of circuit technology and measurement methods in measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- A multi-media CD ROM with script and exercises is available for the lecture</li> <li>- Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827</li> <li>- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926</li> <li>- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263</li> <li>- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175</li> <li>- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Measurement Electronics	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			
Measurement Electronics	1,0	Exercise	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			

<b>Title</b>	Measurement Electronics with Experiments		
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

Measurement Electronics	2,0	Lecture	german
-------------------------	-----	---------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Measurement Electronics	1,0	Exercise	german
-------------------------	-----	----------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Electronics measurement internship	3,0	Internship	german
------------------------------------	-----	------------	--------

**Literature**

Internship script

<b>Title</b>	Identification of Dynamic Systems		
<b>Number</b>	2412380	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-38	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Marcus Grobe
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>	Lecture "Fundamentals of Control Engineering"		
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
Statistical basics, closed-loop identification, excitation signals for identification, least square method, bias-free estimation, method of instrumental variables, Box-Jenkins, maximum likelihood method, Cor-LS method.			
<b>Objective qualification</b>			
After completing the module, students will be able to determine model parameters for linear systems using statistical methods (identification) and evaluate algorithms for their determination.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- E. Hänsler: Statistische Signale</li> <li>- Grundlagen und Anwendungen, Springer-Verlag, ISBN: 978-3540416449</li> <li>- R. Isermann: Identifikation dynamischer Systeme I &amp; II, Springer-Verlag, ISBN: 978-3540549246 &amp; 978-3540554684</li> <li>- L. Ljung: System Identification, Prentice Hall, ISBN: 978-0136566953</li> <li>- W. Leonhard: Statistische Analyse linearer Regelsysteme, Teubner-Verlag, ISBN: 978-3519020462</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

Technische Universität Braunschweig | Module Guide: Electrical Engineering and Information Technology (Bachelor)

	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Advanced Control Engineering		
<b>Number</b>	2412390	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-39	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>	Prerequisite: Lecture "Fundamentals of Control Engineering"		
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes), depending on number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Continuation and application of linear control theory, meshed control loops, multivariable control, simple nonlinear control systems: two- and three-step controllers, state space equations, state space control, state space, description function, stability criteria for nonlinear control systems.			
<b>Objective qualification</b>			
After completing the module, students are able to apply advanced control engineering knowledge in the area of multivariable control of linear systems in state space (state controller, observer, disturbance compensation).			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- J. Lunze: Regelungstechnik 2, Springer-Verlag, ISBN: 978-3540784623</li> <li>- O. Föllinger: Nichtlineare Regelungen 1 &amp; 2, Hüthig-Verlag, ISBN: 978-3486245271 &amp; 978-3486225037</li> <li>- W. Leonhard: Einführung in die Regelungstechnik, Vieweg-Verlag, ISBN: 978-3528535841</li> </ul>			
<b>Remark</b>			
Prerequisite: Lecture "Fundamentals of Control Engineering"			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Exercise	german
	2,0	Lecture	german

<b>Title</b>	Data Bus Systems		
<b>Number</b>	2412400	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-40	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes), depending on the number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Bus architectures and access methods</li> <li>- Physical layers</li> <li>- Network and transport layer according to ISO layer model using the example of the OSEK standard for Network communication and management</li> <li>- LIN, CAN, TTP, FlexRay, MOST and Bluetooth</li> <li>- Interbus, Profibus, HART, ASI</li> <li>- Procedure for the selection of a suitable data bus system for a selected application</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students have basic knowledge of architectures and protocol standards of data bus systems in modern motor vehicles as well as industrial plants. They are familiar with functional principles and properties of commonly used data buses from various application areas. The fundamentals learned enable them to independently design or analyze and evaluate networked systems.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Zimmermann, Schmidgall, Bussysteme in der Fahrzeugtechnik, Vieweg Verlag 2006, ISBN 3-8348-0166-6</li> <li>- G. Schnell, B. Wiedemann, Bussysteme in der Automatisierungs- und Prozesstechnik, Vieweg Verlag 2006, ISBN 3-8348-0045-7</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
both lectures and exercises must be attended			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Foliensammlung</li> <li>- Literaturempfehlungen in der Vorlesung</li> <li>- Etschberger, Controller-Area-Network, Hanser Verlag</li> <li>- Grzempa: LIN-Bus, Franzis Verlag</li> <li>- Rausch: Flexray, Hanser Verlag</li> <li>- Schäuffele: Automotive Software Engineering, Vieweg Verlag</li> <li>- Zimmermann: Bussysteme in der Fahrzeugtechnik, Vieweg Verlag</li> <li>- Schnell, Wiedemann: Bussysteme in der Automatisierungs- und Prozesstechnik</li> </ul>			
	1,0	Exercise	german

<b>Title</b>	High-Voltage Safety in the Motor Vehicle		
<b>Number</b>	2412650	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-65	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes)		
<b>Course achievement</b>	Lab course		
<b>Contents</b>			
<p>The contents result primarily from the qualification measures QM2b+3a of the German Legal Accident Insurance (DGUV) Information 200-005 for work on vehicles with high-voltage systems. Electrotechnical work in a voltage-free state on non-HV intrinsically safe systems level 2 according to DGUV Information 200-005" and working under voltage and near touchable live parts Level 3 according to DGUV Information 200-005".</p>			
<b>Objective qualification</b>			
<p>After completing this module, the students have basic knowledge on HV safety resulting from the qualification measures QM2b+3a of DGUV Information 200-005 for work on vehicles with high-voltage systems. They achieved in particular, an understanding of the electrical hazards associated with the use of HV systems in vehicles. The students will understand and be able to apply appropriate processes guaranteeing safety and health in electrotechnical work under high voltage. The qualification is documented with the successful participation in the practical exercises as well as a proof of the acquired skills and knowledge by an examination.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Folien zum Seminarinhalt</li> <li>• Arbeitsblätter</li> <li>• Gesetzliche Unterlagen wie:</li> <li>• DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686)</li> <li>• ECE R 100</li> <li>• DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)</li> </ul>			
<b>Remark</b>			
<p>Compulsory attendance at the seminar: Participation in the seminar is required and recorded by attendance list and signature. It will be carried out short tests on the individual contents in the event.</p>			

The attendance as well as the tests in the seminar are mandatory so that the lecturer is able to assess the individual level of knowledge and training of the participants as well as their personal suitability before the students will perform experiments of their own.

Limitation of the number of participants:

The number of participants is limited to 20 people so that the required practical part is sufficiently can be mediated.

Additional note:

The practical exercises take place at the institute's training stands. Training contents include measurements of the output voltages on a frequency converter and the replacement of battery cells. These works will be performed under high voltage. If they are not carried out in accordance with the regulations and with the necessary knowledge, they are life threatening. It is therefore important to reduce the risk for students. The lecturer must therefore obtain an overview of the level of knowledge and training of the participants as well as their personal suitability in advance. This goal is achieved through compulsory attendance and tests in the seminar.



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Seminar	german
<b>Literature</b>			
Folien zum Seminarinhalt Arbeitsblätter Gesetzliche Unterlagen wie: DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686) ECE R 100 DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)			
	1,0	Internship	german
<b>Literature</b>			
Folien zum Seminarinhalt Arbeitsblätter Gesetzliche Unterlagen wie: DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686) ECE R 100 DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)			

<b>Title</b>	Automotive Systems Engineering		
<b>Number</b>	2412660	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-66	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	written exam (60 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- architectures in vehicle development</li> <li>- development processes for complex automotive systems</li> <li>- simulation, test and development methods for complex automotive systems</li> <li>- safety requirements and concepts</li> <li>- software components and architectures</li> <li>- formal description methods</li> <li>- examples from driver assistance and electric mobility</li> </ul>			
<b>Objective qualification</b>			
<p>Handling complexity in the development and production process is one of the core competencies of today's car manufacturers. After completing this module, students will have an overview of established and innovative methods for handling complexity in vehicle development. They learn about architectures, methods for requirements management, processes, description methods as well as test, simulation and development tools for vehicle development.</p> <p>After completing this module, students will be able to analyze and enhance existing processes, and development and test methods in companies. Students become capable to design innovative automotive systems.</p> <p>Special attention will be paid to the safety of the systems during the design activities. For given tasks, they learn to derive requirements for the systems systematically.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• J. Schäuffele, T. Zurawka: Automotive Software Engineering, Vieweg Verlag, ISBN: 978-3834800510</li> <li>• Maurer, Markus, et al. Autonomous driving: technical, legal and social aspects. Springer Nature, 2016.</li> <li>• Schröder, Tobias, et al. "Compensating for the Absence of a Required Accompanying Person: A Draft of a Functional System Architecture for an Automated Vehicle." 2021 IEEE International Intelligent Transportation Systems Conference (ITSC). IEEE, 2021.</li> <li>• Nolte, Marcus, et al. "Supporting Safe Decision Making Through Holistic System-Level Representations &amp; Monitoring--A Summary and Taxonomy of Self-Representation Concepts for Automated Vehicles." arXiv preprint arXiv:2007.13807 (2020).</li> <li>• Jatzkowski, Inga, et al. "A Knowledge-based Approach for the Automatic Construction of Skill Graphs for Online Monitoring." 2021 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2021.</li> </ul>			

- Graubohm, Robert, et al. "Towards efficient hazard identification in the concept phase of driverless vehicle development." 2020 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2020.
- Stolte, Torben, et al. "Towards Safety Concepts for Automated Vehicles by the Example of the Project UNICARagil." 29th Aachen Colloquium Sustainable Mobility 2020, 5.–7. Oktober 2020. 2020.
- Menzel, Till, et al. "From functional to logical scenarios: Detailing a keyword-based scenario description for execution in a simulation environment." 2019 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2019.
- Nolte, Marcus, et al. "Representing the Unknown–Impact of Uncertainty on the Interaction between Decision Making and Trajectory Generation." 2018 21st International Conference on Intelligent Transportation Systems (ITSC). IEEE, 2018.
- Bagschik, Gerrit, et al. "A system's perspective towards an architecture framework for safe automated vehicles." 2018 21st International Conference on Intelligent Transportation Systems (ITSC). IEEE, 2018.
- Menzel, Till, Gerrit Bagschik, and Markus Maurer. "Scenarios for development, test and validation of automated vehicles." 2018 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2018.
- Matthaei, Richard, and Markus Maurer. "Functional system architecture for an autonomous on-road motor vehicle." Automotive Systems Engineering II. Springer, Cham, 2018. 93-120.
- Stolte, Torben, et al. "Hazard analysis and risk assessment for an automated unmanned protective vehicle." 2017 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2017.
- Ulbrich, Simon, et al. "Defining and substantiating the terms scene, situation, and scenario for automated driving." 2015 IEEE 18th international conference on intelligent transportation systems. IEEE, 2015.

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Markus Maurer (Hrsg), Hermann Winner (Hrsg): Automotive Systems Engineering, Springer Verlag, 2013 J. Schäuffele, T. Zurawka: Automotive Software Engineering, Vieweg Verlag, ISBN: 978-3834800510			
	2,0	Exercise	german
<b>Literature</b>			
Markus Maurer (Hrsg), Hermann Winner (Hrsg): Automotive Systems Engineering, Springer Verlag, 2013 J. Schäuffele, T. Zurawka: Automotive Software Engineering, Vieweg Verlag, ISBN: 978-3834800510			

<b>Title</b>	Computer Architecture 1		
<b>Number</b>	2416010	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-01	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	4 / 6,0	<b>Module owner</b>	Prof. Dr. Selma Saidi
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	124
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Introduction to computer architecture</li> <li>• Principles of computer architecture (control, pipelining, memory hierarchy)</li> <li>• Microprocessors (RISC, ISC)</li> <li>• Quantitative computer design</li> <li>• Design of instruction sets</li> </ul>			
<b>Objective qualification</b>			
Students have basic knowledge of modern computer architectures and an understanding of the function of modern computers. With the knowledge they have acquired, they are able to configure computer systems on a component basis and evaluate their performance.			
<b>Literature</b>			
D. Patterson, J. L. Hennessy, Computer Organization and Design #– The Hardware/Software Interface, Morgan Kaufmann Publishers, ISBN 978-0-12-370606-5 # W. Stallings, Computer Organization & Architecture, 6. Edition, Prentice Hall, ISBN-13: 978-0-13-035119-7 # Lecture notes			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,0	Exercise	german
	3,0	Lecture	german

<b>Title</b>	Computer Architecture Basics and Lab		
<b>Number</b>	2416620	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-62	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	8 / 10,0	<b>Module owner</b>	Prof. Dr. Rolf Ernst
<b>Workload (h)</b>	300		
<b>Class attendance (h)</b>	112	<b>Self studying (h)</b>	188
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 Minutes)		
<b>Course achievement</b>	Lab course		
<b>Contents</b>			
<p>Introduction to computer architecture  Principles of computer architecture (control, pipelining, memory hierarchy)  Microprocessors (RISC, ISC)  Quantitative computer design and design of instruction sets  Practical experiments in the following areas  Metrological investigation of line effects and synchronisation methods  Assembler and automaton implementation on microcontrollers  Circuit design using hardware design languages  Circuit synthesis</p>			
<b>Objective qualification</b>			
<p>The students have basic knowledge of modern computer architectures and an understanding of the function of modern computers. With the knowledge they have acquired, they are able to configure computer systems on a component basis and evaluate their performance.  In the Lab course, students will be able to design simple circuits and embedded software and evaluate the result in terms of its logical and temporal behaviour by means of measurements or simulation. They will be able to formulate and implement a hardware design in a design language and gain an overview of the phases of a complex hardware design. In accordance with the didactic concept of the course and the design of the individual components, interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation, dialogue and presentation techniques as well as teamwork in the laboratory or project.</p>			
<b>Literature</b>			
<p>-# Computer Organization and Design  - The Hardware/Software Interface, 3rd edition, David A. Patterson and John L. Hennessy  - Lecture / lab notes</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,0	Exercise	german
	4,0	Internship	german
	3,0	Lecture	german

<b>Title</b>	Embedded Computing Systems and Lab (2013)		
<b>Number</b>	2416630	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-63	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	8 / 10,0	<b>Module owner</b>	Prof. Dr. Rolf Ernst Prof. Dr. Selma Saidi
<b>Workload (h)</b>	300		
<b>Class attendance (h)</b>	112	<b>Self studying (h)</b>	188
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>	Lab course		
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Introduction to computer architecture</li> <li>• Principles of computer architecture (control, pipelining, memory hierarchy)</li> <li>• Microprocessors (RISC, ISC)</li> <li>• Quantitative computer design and design of instruction sets</li> <li>• Practical experiments from the following areas</li> <li>• Construction of an Application Specific Instruction Set Processor (ASIP)</li> <li>• Hardware design with a hardware description language (VHDL)</li> <li>• Programming / extension of the software for the ASIP (C)</li> <li>• Hardware / software co-design</li> <li>• Implementation of applications on an ASIP.</li> </ul>			
<b>Objective qualification</b>			
<p>The students have basic knowledge of modern computer architectures and an understanding of the function of modern computers. With the knowledge they have acquired, they are able to configure computer systems on a component basis evaluate their performance.</p> <p>In the Embedded Processors lab course, students learn about the areas of application and utilization potential of Application Specific Instruction Set Processors (ASIPs). They are then able to break down larger tasks into sub-problems and solve them in teamwork. They will have mastered the competent use of complex tools and design processes for hardware and software design.</p> <p>In accordance with the didactic concept of the course and the design of the individual components, interdisciplinary qualifications are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation, dialogue and presentation techniques as well as teamwork in the laboratory or project.</p>			
<b>Literature</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,0	Exercise	german
	3,0	Lecture	german
	4,0	Internship	german

<b>Title</b>	Electromagnetic Compatibility		
<b>Number</b>	2419120	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Dr. Harald Spieker
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Terms and definitions of EMC</li> <li>• Sources of interference and disturbance variables, immunity of susceptible devices #</li> <li>• Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference #</li> <li>• Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection #</li> <li>• Legal basis, product liability, standardization #</li> <li>• EMC test engineering #</li> <li>• Electromagnetic compatibility of biological systems</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able assess the EMC product safety by failure mechanisms.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- Joachim Franz, EMV – Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X</li> <li>- Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1</li> <li>- Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Either this module or "Electromagnetic Compatibility with Seminar" can be selected.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electromagnetic Compatibility	2,0	Lecture	german
Electromagnetic Compatibility	1,0	Exercise	german

<b>Title</b>	Digital Signal Processing		
<b>Number</b>	2424020	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-02	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	5 / 8,0	<b>Module owner</b>	Prof. Dr. Tim Fingscheidt
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	170
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>	protocol to the laboratory experiments		
<b>Contents</b>			
<p>Discrete-time signals and systems  Fourier transforms for discrete-time signals and systems  Z-transform and applications  Discrete-time IIR filter design  Discrete-time FIR filter design  Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)  Basics of multi-rate processing and filter banks</p>			
<b>Objective qualification</b>			
<p>After completing this module including the computer exercise, students will have basic knowledge on the tools of digital signal processing in the time and frequency domain and can apply these tools to corresponding problems. In accordance with the didactic concept of the course and the design of the individual components, general qualifications are imparted or practiced. As part of the computer exercise and the associated colloquium, these are documentation, interviewing and presentation techniques as well as teamwork in the lab.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture slides</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Zeitdiskrete Signalverarbeitung", Pearson Verlag, 2004</li> <li>- K.D. Kammeyer, K. Kroschel: "Digitale Signalverarbeitung", Teubner Verlag, 2002</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Discrete Time Signal Processing", Prentice-Hall, 2004</li> <li>- H.-W. Schüßler: "Digitale Signalverarbeitung 1", Springer Verlag, 1994</li> </ul>			
<b>Remark</b>			
German			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Zeitdiskrete Signalverarbeitung, Pearson Studium, 2004</li> <li>• K. D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung, Teubner Verlag, 2002</li> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete Time Signal Processing, Prentice Hall, 2004</li> <li>• H.-W. Schüßler: Digitale Signalverarbeitung, Springer Verlag, 1994</li> </ul>			
	2,0	Laboratory	german
<b>Literature</b>			
siehe Vorlesung			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

<b>Title</b>	Fundamentals of Digital Signal Processing		
<b>Number</b>	2424480	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-48	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tim Fingscheidt
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Discrete-time signals and systems #</li> <li>- Fourier transforms #</li> <li>- Z-transforms and applications #</li> <li>- Discrete-time IIR filter design #</li> <li>- Discrete-time FIR filter design #</li> <li>- Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) #</li> <li>- Basics of multi-rate processing and filter banks</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students will have basic knowledge on the tools of digital signal processing in the time and frequency domain and can apply these tools to corresponding problems.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Zeitdiskrete Signalverarbeitung" , Pearson Verlag, 2004</li> <li>- K.D. Kammeyer, K. Kroschel: "Digitale Signalverarbeitung" , Teubner Verlag, 2002</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Discrete Time Signal Processing" , Prentice-Hall, 2004</li> <li>- H.-W. Schüßler: "Digitale Signalverarbeitung 1" , Springer Verlag, 1994</li> </ul>			
<b>Remark</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Zeitdiskrete Signalverarbeitung, Pearson Studium, 2004</li> <li>• K. D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung, Teubner Verlag, 2002</li> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete Time Signal Processing, Prentice Hall, 2004</li> <li>• H.-W. Schüßler: Digitale Signalverarbeitung, Springer Verlag, 1994</li> </ul>			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

<b>Title</b>	Electrochemical storages embedded in on-board power systems		
<b>Number</b>	2419000000	<b>Module version</b>	
<b>Shorttext</b>		<b>Language</b>	english
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Michael Terörde
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam, 30 minutes or written exam, 90 minutes		
<b>Course achievement</b>			
<b>Contents</b>			
<p><b>On-board power system topics:</b> On-board power networks of aircraft, automobiles, ships and satellites, protection elements of on-board networks, calculation of simple circuit diagrams, network shapes, simulations of energy systems, power electronic switches in on-board networks.</p> <p><b>Electrochemical storage systems:</b> batteries, fuel cells, hydrogen as an energy carrier, super capacitors, power to gas concept, thermal behavior and current and voltage characteristics of the storage systems</p>			
<b>Objective qualification</b>			
<p>After completing the module, students will be able to evaluate the integration of different electrochemical energy storage systems in different types of vehicles. They will be able to derive simple electrical equivalent circuit diagrams from vehicle electrical system circuit diagrams and use them to perform calculations with regard to electrical parameters. They will be able to explain details of the design and operation of fuel cells, batteries and double-layer capacitors.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Elective areas: Energy Systems and Drive Technologies/Powertrain, Autonomous Intelligent Systems			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electrochemical storages embedded in on-board power systems	2,0	Lecture	english
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			
Electrochemical storages embedded in on-board power systems	1,0	Exercise	english
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			

<b>Title</b>	Model Vehicle Design		
<b>Number</b>	2412000000	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-69	<b>Language</b>	
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1 Semester	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Project work		
<b>Course achievement</b>			
<b>Contents</b>			
<p>In this course, participants are introduced to a selection of processes for manufacturing mechanical and electrical assemblies. In addition, the theoretical principles of project management are explained. After an introduction, the participants independently design a model vehicle with defined functionalities in smaller teams. In addition to time constraints, the available resources and manufacturing processes must be taken into account. The realization of the model vehicles takes place mainly in the institute's own workshop under the instruction of the technical staff. In a concluding event, the participants present their work steps and results.</p>			
<b>Objective qualification</b>			
<p>After completing this module, the participants are familiar with a selection of manual processes for creating mechanical and electrical components. They are also able to independently design and implement a functional assembly, taking into account the available manufacturing processes. Furthermore, the participants are familiar with the basics of project management and have gained practical experience with project implementation in smaller working groups.</p>			
<b>Literature</b>			
Slides and working sheets			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Seminar	german
	1,0	Internship	german

<b>Title</b>	Measurement Electronics with Experiments		
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	english
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

Measurement Electronics	2,0	Lecture	german
-------------------------	-----	---------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Measurement Electronics	1,0	Exercise	german
-------------------------	-----	----------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Electronics measurement internship	3,0	Internship	german
------------------------------------	-----	------------	--------

**Literature**

Internship script

<b>Title</b>	Application of Control Engineering Methods		
<b>Number</b>	2412000010	<b>Module version</b>	
<b>Shorttext</b>		<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Recommended requirements</b>	Fundamentals of Control Engineering (can be done parallel), max number of participants: 16		
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
Modeling, representation in the time and frequency domain, computer-aided solution of differential equations, step responses, impulse responses, Laplace transformation, Bode diagram, locus curve, typical individual elements of controlled systems, transfer function, controller design of standard controllers, equivalent time constant, cascade control, computer-aided tools for control engineering tasks			
<b>Objective qualification</b>			
After completing the module, students will have basic knowledge in the field of linear control engineering as well as in-depth knowledge of the use of computer-aided applications for simulation, controller design and the application of the theoretical content taught. They are familiar with the properties and dynamic behavior of basic control engineering components and methods of classical controller design. They understand the concepts for describing linear and simple non-linear dynamic systems in the time and frequency domain as well as the concept of the Laplace transformation. You will be able to model linear time-invariant systems with concentrated memories and design standard controllers in the frequency domain. This includes the design using pole placement, the modelling of equivalent time constants, as well as working in the Bode diagram and the design of multi-loop controller structures.			
<b>Literature</b>			
<b>Remark</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Application of Control Engineering Methods	2,0	Lecture	german
Application of Control Engineering Methods	2,0	Exercise	german

**Optional Subjects Information Technologies**

<b>Title</b>	Integrated Circuits		
<b>Number</b>	2413280	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-28	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Vadim Issakov
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (20 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>The module provides an overview of the operation, design, and technology of integrated electronic circuits in microelectronics.</p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Basic digital circuits</li> <li>• MOS and CMOS</li> <li>• Silicon wafer manufacturing</li> <li>• MOSFET process technology</li> <li>• Nanolithography</li> <li>• Etching techniques and oxidation</li> <li>• Design automation, design rules, and assembly techniques</li> <li>• Back-end technologies</li> <li>• Modern developments: Memory technologies</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module, students will be able to understand integrated circuits, their structure and mode of operation and design simple integrated circuits themselves. A further focus is on the methods of nanotechnology.</p>			
<b>Literature</b>			
<p>Lecture slides and short script  J.M.Rabaey, A.Chandrakasan, B. Nikolic, Digital Integrated Circuits  Prentice Hall Electronics and VLSI Series, 2002 ISBN: 8120322576  A. Schlachetzki, Integrierte Schaltungen, Teubner, 1978, (as copy at IHT) ISBN: 3-519-03070-5  D. Widmann, H. Mader, H. Friedrich, Technologie Hochintegrierte Schaltungen, Springer, 1996  ISBN:3540593578  W. Prost, Technologie der III/V Halbleiter, Springer, 1997 ISBN: 3540628045</p>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzschrift K.-H. Cordes, A. Waag, N. Heuck : Integrierte Schaltungen; Pearson Studium, 2010 J.M.Rabaey, A.Chandrakasan, B. Nikolic, Digital Integrated Circuits Prentice Hall Electronics and VLSI Series, 2003, 1996 A. Schlachetzki, Integrierte Schaltungen, Teubner, 1978, (als Kopie im IHT) D. Widmann, H. Mader, H. Friedrich, Technologie Hochintegrierte Schaltungen, Springer, 1996 W. Prost, Technologie der III/V # Halbleiter, Springer, 1997			
	1,0	Exercise	german
<b>Literature</b>			
K.-H. Cordes, A. Waag, N. Heuck : Integrierte Schaltungen; Pearson Studium, 2010			

<b>Title</b>	Optical Communications with Lab		
<b>Number</b>	2415220	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-22	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 6,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	124
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Optical fibers</li> <li>- Dispersion, velocities of light</li> <li>- Coherent modulation</li> <li>- Coherent receiver</li> <li>- Laser</li> <li>- Optical amplifier</li> <li>- Optoelectronic modulators</li> <li>- Photodetectors</li> <li>- Systems of optical communications</li> </ul>			
<b>Objective qualification</b>			
After completing the module, the students understand the mode of operation and know the performance characteristics of different components of optical transmission links. They can design and dimension fibre-optic transmission links.			
<b>Literature</b>			
S. L. Chuang, Physics of Photonic Devices, Wiley & Sons, ISBN 9780470293195			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Lecture	german
<b>Literature</b>			
- Skript zur Vorlesung - S. L. Chuang, Physics of Optoelectronic Devices, John Wiley & Sons			
	1,0	Exercise	german
	1,0	Laboratory	english
<b>Literature</b>			
Skript zum Praktikum			

<b>Title</b>	RF and Microwave Systems and Circuits		
<b>Number</b>	2415390	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-39	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Jörg Schöbel
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	written exam (90 minutes) or oral exam (30 minutes) or homework or semester project		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- radio transmission systems, system concepts and components</li> <li>- system/link budget, noise, nonlinear distortion</li> <li>- oscillators, phase noise, PLL</li> <li>- introduction to microwave circuits, Smith chart, matching structures</li> <li>- passive components: couplers, SAW filters, ferrites (isolators, circulators)</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module, students have an overview of systems and components in radio transmission systems as well as a basic understanding of the associated RF circuits. They have gained basic experience in the design of transmission systems and of exemplary components using commercial design software. They are also familiar with the most important characterisation methods and have the basic skills to specify and to design transmission systems and their components.</p>			
<b>Literature</b>			
Pozar, Microwave Engineering, Wiley, ASIN B001QA4I9C Unger, Harth, Hochfrequenz-Halbleiterelektronik, Hirzel, ISBN 3777602353			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Exercise	german
	2,0	Lecture	german

<b>Title</b>	Linear photonics with practical course		
<b>Number</b>	2415500	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-50	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min) or oral exam (30 min)		
<b>Course achievement</b>	Lab work		
<b>Contents</b>			
Ray optics, wave optics, Fourier optics, electromagnetic optics, quantum optics with practical experiments on: lenses, imaging, refraction, diffraction, interferometers, determination of optical constants, polarisation, Fourier optics, holography, laser, waveguide optics, quantum optics.			
<b>Objective qualification</b>			
After completing the module, the students know the essential fundamentals of modern photonics and can apply this knowledge to the assessment, design and simulation of photonic systems. Through the practical experiments offered, the students gain additional practical experience.			
<b>Literature</b>			
B.E.A. Saleh, M.C. Teich, Fundamentals of Photonics, (Wiley Series in Pure and Applied Optics)			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

	2,0	Internship	german
<b>Literature</b>			
B.E.A. Saleh, M.C. Teich, Fundamentals of Photonics, (Wiley Series in Pure and Applied Optics)			

<b>Title</b>	Linear Photonics		
<b>Number</b>	2415510	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-51	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
Ray optics, wave optics, Fourier optics, electromagnetic optics, quantum optics with practical experiments on: lenses, imaging, refraction, diffraction, interferometers, determination of optical constants, polarisation, Fourier optics, holography, laser, waveguide optics, quantum optics.			
<b>Objective qualification</b>			
After completing the module, the students know the essential basics of modern photonics and are thus able to assess photonic and optical systems and technologies.			
<b>Literature</b>			
B. E. A. Saleh, M. C. Teich #Fundamentals of Photonics# John Wiley & Sons			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Communication Networks for Engineers		
<b>Number</b>	2416490	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-49	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Admela Jukan
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>* Basic network topologies and protocol architectures</li> <li>* Transmission systems and multiplexing methods</li> <li>* Selected protocol mechanisms</li> <li>* LAN protocols</li> <li>* Basics of the Internet and the IP protocol</li> <li>* Routing in the Internet</li> <li>* The TCP protocol and its performance evaluation</li> <li>* High-speed networks (MPLS, Ethernet and optical networks)</li> <li>* Network security</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students have basic knowledge of architectures and protocol standards of communications networks and are familiar with the principles of signalling. The acquired fundamentals enable them to analyze and evaluate new protocols and switching technology procedures.			
<b>Literature</b>			
<p>W. Stallings, Data and Computer Communications, Pearson Prentice Hall, 2004, ISBN: 0-13-183311-1 #          B. Mukherjee, Optical WDM networks, Springer, 2006, ISBN: 0-387-29055-9 #          J. F. Kurose und K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Addison Wesley, 2005, ISBN: 0-321-26976-4</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,0	Exercise	german
<b>Literature</b>			
* Skript * J.F. Kuruse und K.W. Ross, Computernetze *W. Stallings, Data and Computer Communications			
	2,0	Lecture	german
<b>Literature</b>			
* Skript * J.F. Kuruse und K.W. Ross, Computernetze *W. Stallings, Data and Computer Communications			

<b>Title</b>	Fundamentals of Communication Networks for engineers		
<b>Number</b>	2416790	<b>Module version</b>	
<b>Shorttext</b>	ET-IDA-79	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Datentechnik und Kommunikationsnetze
<b>Hours per Week / ECTS</b>	7 / 9,0	<b>Module owner</b>	Prof. Dr. Admela Jukan
<b>Workload (h)</b>	270		
<b>Class attendance (h)</b>	98	<b>Self studying (h)</b>	172
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>	Laboratory practical exercises (§ 4 Para. 14)		
<b>Contents</b>			
<p>Basic network structures and protocol architectures  Transmission systems and multiplexing methods  Selected protocol mechanisms  LAN Protocols  Basics of the Internet and the IP protocol  Routing protocols and algorithms  The TCP protocol and its performance evaluation  Basics of network security  New network architectures and protocols (SDN, MPLS)</p> <p>Practical experiments from one of the two areas:</p> <p>Internet protocols with emphasis on:  Single-segment IP networks and statistical routing  Dynamic routing protocols RIP, OSPF and BGP  Transport protocols UDP and TCP</p> <p>IoT networks and systems with the following focus:  Basics of sensors, microcontrollers and Linux OS  Basics of network and WiFi access protocols.  The Message Queuing Telemetry Transport Protocol (MQTT)  Local Data Processing (Fog Computing) for IoT Devices  Remote data processing (cloud computing) using HTTP+REST</p>			
<b>Objective qualification</b>			
<p>After completing this module, students have basic knowledge of architectures, protocol standards and theoretical aspects of telecommunication networks as well as computer networks and are familiar with the principles of signalling. The fundamentals learnt enable them to design, analyze and evaluate new protocols and switching procedures.</p>			

In the practical lab course Communication Networks and System, the students acquire basic practical knowledge of the protocols and algorithms used on the Internet. The students are able to configure protocols. They are familiar with tools for analyzing real-world network traffic and are able to use these tools to verify the functionality and performance of protocols.

In the practical lab course Design of IoT Networks and Systems, students acquire basic practical knowledge of the design of new network technologies, network systems and protocols from the areas of the Internet of Things (IoT) and cloud computing.

Internet of Things (IoT) and cloud applications together with their integrated application. The students are able to solve problem-specific tasks and integrate them in teamwork into a IoT use case. They know hardware and software tools for analyzing IoT-specific applications and are able to evaluate and verify their functionality.

**Literature**

Lecture notes #

J. F. Kurose und K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Addison Wesley, 2005, ISBN: 0-321-26976-4 #

W. Stallings, Data and Computer Communications, Pearson Prentise Hall, 2004, ISBN: 0-13-183311-1 #

L. L. Peterson und B. S. Davie, Computer Networks: A Systems Approach, Morgan Kaufmann Publishers, 2003, ISBN: 1-55860-833-8

J. Liebeherr und M. El Zarki,: Mastering Networks -An Internet Lab Manual-, Pearson, 2004, ISBN: 0-201-78134-4



**Related courses**

**Rules for the choice of courses**

One of the two labs must be taken.

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

	4,0	Internship	german
--	-----	------------	--------

**Literature**

J. Liebeherr und M. El Zarki,: Mastering Networks -An Internet Lab Manual-, Pearson, 2004, ISBN: 0-201-78134-4

	1,0	Exercise	german
--	-----	----------	--------

**Literature**

\* Skript \* J.F. Kuruse und K.W. Ross, Computernetze \*W. Stallings, Data and Computer Communications

	2,0	Lecture	german
--	-----	---------	--------

**Literature**

\* Skript \* J.F. Kuruse und K.W. Ross, Computernetze \*W. Stallings, Data and Computer Communications

	5,0	Internship	english
--	-----	------------	---------

<b>Title</b>	Electromagnetic Compatibility		
<b>Number</b>	2419120	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Dr. Harald Spieker
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Terms and definitions of EMC</li> <li>• Sources of interference and disturbance variables, immunity of susceptible devices #</li> <li>• Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference #</li> <li>• Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection #</li> <li>• Legal basis, product liability, standardization #</li> <li>• EMC test engineering #</li> <li>• Electromagnetic compatibility of biological systems</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able to assess the EMC product safety by failure mechanisms.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- Joachim Franz, EMV – Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X</li> <li>- Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1</li> <li>- Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Either this module or "Electromagnetic Compatibility with Seminar" can be selected.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electromagnetic Compatibility	2,0	Lecture	german
Electromagnetic Compatibility	1,0	Exercise	german

<b>Title</b>	Lab Course for Circuit Design		
<b>Number</b>	2420130	<b>Module version</b>	
<b>Shorttext</b>	ET-BST-13	<b>Language</b>	german
<b>Frequency of offer</b>	irregular	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für CMOS Design
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	80
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	Colloquium/lab journal as proof of achievement		
<b>Contents</b>			
<p>Lab Circuit Design:            In the exercise, the necessary theoretical knowledge of the homodyne receiver to be set up in the laboratory is acquired.            In the laboratory, a homodyne receiver (direct conversion receiver) for the 20m shortwave amateur radio band is completely constructed from discrete components. This receiver architecture, which does not require an intermediate frequency, is used in many modern mobile radio receivers (GSM, UMTS, WLAN, BLUETOOTH). The receiver consists of the following stages: Input amplifier, mixer, oscillator, baseband filter, AF preamplifier, and AF power amplifier. All stages are modeled one after the other using various modern circuit simulators, built discretely on a circuit board and carefully measured. The functionality of the overall circuit is demonstrated in detail in the final experiment.</p> <p>Lab PSpice:            In the exercise, the application of the simulator with its various types of analysis is presented. Basic circuits (source, gate and drain circuits), CMOS circuits such as cascode, differential amplifier, current mirror and simple operational amplifier circuits are dealt with in the laboratory.            In recent decades, PSPICE has developed into an industrial standard tool for circuit simulation, which is used in the design of analog circuits.            The transistor models required for simulation, which are kindly provided by the IHP Leibnitz Institute in Fankfurt/Oder, correspond to a real 0.25um technology from Motorola.</p>			
<b>Objective qualification</b>			
<p>Lab Circuit Design:            The students know how to set up, simulate and test a shortwave homodyne receiver.</p> <p>Lab PSpice:            Students can carry out circuit simulations with transistor models commonly used in industry on the basis of PSpice, closely following the content of the lecture "Circuit design". The simulation results in a better insight of the circuits and enables the investigation of important effects of real circuits that can no longer be determined by analytical manual calculation.</p>			
<b>Literature</b>			

R. Heinemann: PSpice-Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3

**Remark**

Usually, the Lab Circuit Design takes place in the winter semester, the Lab PSpice in the summer semester.



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<p>Alternatively:</p> <ul style="list-style-type: none"> <li>- Circuit design (Lab + exercise)</li> <li>- PSpice (Lab + exercise)</li> </ul> <p>The PSpice practical course can be taken parallel to the lecture on circuit design.</p> <p>Recommendation: Knowledge of the modules "Circuit Theory" and "Circuit Design".</p>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	4,0	Internship	german
	2,0	Exercise	german
<b>Literature</b>			
R. Heinemann: PSPICE - Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3			
	2,0	Internship	german
<b>Literature</b>			
R. Heinemann: PSPICE - Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3			
	1,0	Exercise	german

<b>Title</b>	Digital Signal Processing		
<b>Number</b>	2424020	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-02	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	5 / 8,0	<b>Module owner</b>	Prof. Dr. Tim Fingscheidt
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	170
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>	protocol to the laboratory experiments		
<b>Contents</b>			
<p>Discrete-time signals and systems  Fourier transforms for discrete-time signals and systems  Z-transform and applications  Discrete-time IIR filter design  Discrete-time FIR filter design  Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)  Basics of multi-rate processing and filter banks</p>			
<b>Objective qualification</b>			
<p>After completing this module including the computer exercise, students will have basic knowledge on the tools of digital signal processing in the time and frequency domain and can apply these tools to corresponding problems. In accordance with the didactic concept of the course and the design of the individual components, general qualifications are imparted or practiced. As part of the computer exercise and the associated colloquium, these are documentation, interviewing and presentation techniques as well as teamwork in the lab.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture slides</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Zeitdiskrete Signalverarbeitung", Pearson Verlag, 2004</li> <li>- K.D. Kammeyer, K. Kroschel: "Digitale Signalverarbeitung", Teubner Verlag, 2002</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Discrete Time Signal Processing", Prentice-Hall, 2004</li> <li>- H.-W. Schüßler: "Digitale Signalverarbeitung 1", Springer Verlag, 1994</li> </ul>			
<b>Remark</b>			
German			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Zeitdiskrete Signalverarbeitung, Pearson Studium, 2004</li> <li>• K. D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung, Teubner Verlag, 2002</li> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete Time Signal Processing, Prentice Hall, 2004</li> <li>• H.-W. Schüßler: Digitale Signalverarbeitung, Springer Verlag, 1994</li> </ul>			
	2,0	Laboratory	german
<b>Literature</b>			
siehe Vorlesung			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

<b>Title</b>	Planning of Terrestrial Radio Networks		
<b>Number</b>	2424410	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-41	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Thomas Kürner
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (20 minutes) or written exam (90 minutes)		
<b>Course achievement</b>	Colloquium or lab journal		
<b>Contents</b>			
<p>Introduction  Radio propagation models  Coverage planning  Planning cellular networks  General principles of cellular network planning  GSM radio network planning  UMTS radio network planning  Planning OFDMA networks</p> <p>As part of the computer exercise, an introduction to the operation and handling of a radio planning tool</p>			
<b>Objective qualification</b>			
<p>After completing the module, students will have an understanding of the essential processes and interrelationships involved in planning terrestrial radio networks and will have acquired knowledge of the data required for this purpose and, in particular, the algorithms, models and methods used. They will be able to solve planning tasks independently using a radio planning tool.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Lecture notes (German and English)</li> <li>• C. Lüders, Mobilfunksysteme, Vogel-Verlag 2001 #</li> <li>• N. Geng, W. Wiesbeck, Planungsmethoden für die Mobilkommunikation, Springer-Verlag 1998</li> <li>• J. Laiho, A. Wacker, T. Novosad, Radio Network Planning and Optimisation for UMTS, Wiley 2002</li> </ul>			
<b>Remark</b>			
This Master's module is also suitable for Bachelor students.			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Laboratory	german
<b>Literature</b>			
siehe Vorlesung			
	2,0	Lecture	german
<b>Literature</b>			
Skript in deutscher und englischer Sprache C.Lüders, Mobilfunksysteme, Vogel-Verlag 2001 N.Geng, W.Wiesbeck, Planungsmethoden für die Mobilkommunikation, Springer-Verlag 1998 J.Laiho, A.Wacker, T.Novosad, Radio Network Planning and Optimisation for UMTS, Wiley 2002			

<b>Title</b>	Fundamentals of Digital Signal Processing		
<b>Number</b>	2424480	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-48	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tim Fingscheidt
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Discrete-time signals and systems #</li> <li>- Fourier transforms #</li> <li>- Z-transforms and applications #</li> <li>- Discrete-time IIR filter design #</li> <li>- Discrete-time FIR filter design #</li> <li>- Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) #</li> <li>- Basics of multi-rate processing and filter banks</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students will have basic knowledge on the tools of digital signal processing in the time and frequency domain and can apply these tools to corresponding problems.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Zeitdiskrete Signalverarbeitung" , Pearson Verlag, 2004</li> <li>- K.D. Kammeyer, K. Kroschel: "Digitale Signalverarbeitung" , Teubner Verlag, 2002</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Discrete Time Signal Processing" , Prentice-Hall, 2004</li> <li>- H.-W. Schüßler: "Digitale Signalverarbeitung 1" , Springer Verlag, 1994</li> </ul>			
<b>Remark</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Zeitdiskrete Signalverarbeitung, Pearson Studium, 2004</li> <li>• K. D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung, Teubner Verlag, 2002</li> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete Time Signal Processing, Prentice Hall, 2004</li> <li>• H.-W. Schüßler: Digitale Signalverarbeitung, Springer Verlag, 1994</li> </ul>			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

<b>Title</b>	Fundamentals of Mobile Radio Communications		
<b>Number</b>	2424490	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-49	<b>Language</b>	english german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Thomas Kürner
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (20 min) or written exam (90 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Wave Propagation</li> <li>3. Radio Transmission</li> <li>4. Media Access</li> <li>5. 3GPP Wireless Systems</li> <li>6. IEEE 802 Wireless Systems</li> </ol>			
<b>Objective qualification</b>			
The lecture provides the basics in the areas of the air interface of mobile communication systems. Students will acquire knowledge on the structure and functionality of cellular and wireless local area networks.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Lecture notes</li> <li>• C. Lüders, Mobilfunksysteme, Vogel-Verlag 2001</li> <li>• # J. Schiller, Mobilkommunikation, Addison-Wesley 2000</li> <li>• N. Geng, W. Wiesbeck, Planungsmethoden für die Mobilkommunikation, Springer-Verlag 1998 #</li> <li>• A. Molisch, Wireless Communications, Addison-Wesley 2005</li> </ul>			
<b>Remark</b>			
This Master's module is also suitable for Bachelor students.			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	1,5	Exercise	english german
<b>Literature</b>			
siehe Vorlesung			
	2,5	Lecture	english german
<b>Literature</b>			
Skript C. Lüders, Mobilfunksysteme, Vogel-Verlag 2001 J. Schiller, Mobilkommunikation, Addison-Wesley 2000 N. Geng, W. Wiesbeck, Planungsmethoden für die Mobilkommunikation, Springer-Verlag 1998 A. Molisch, Wireless Communications, Addison-Wesley 2005			

<b>Title</b>	Digital Signal Transmission		
<b>Number</b>	2424660	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-66	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Eduard Jorswieck
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (180 minutes) or oral exam (30 minutes), depending on number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Part I:</p> <ul style="list-style-type: none"> <li>- Deterministic signals in LTI systems</li> <li>- Fourier transform</li> <li>- Discrete signals and systems</li> <li>- Correlation function of deterministic signals</li> <li>- System theory of low-pass and band-pass systems</li> </ul> <p>Part II:</p> <ul style="list-style-type: none"> <li>- Statistical signal processing</li> <li>- Multiplexing</li> <li>- Binary transmission with low-pass signals</li> <li>- Binary transmission with band-pass signals</li> <li>- Digital modulation</li> </ul>			
<b>Objective qualification</b>			
The students describe signal processing systems by their impulse response or transfer function. They know the fundamental principles of digital communications systems.			
<b>Literature</b>			
- Proakis, John G., and Masoud Salehi. Digital communications. Vol. 4. New York: McGraw-Hill, 2001.			
<b>Remark</b>			
First half of the summer semester: Digital Signal Transmission I, second half: Digital Signal Transmission II (4+2 SWS / week). Recommended Recommended prerequisite: module Fundamentals of Information Technology.			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Ohm, Lüke: Signalübertragung, Springer-Verlag, ISBN 3-540-67768-2 Reimers: Digitale Fernsehtechnik, 2. Aufl., ISBN 3-540-60945-8			
	2,0	Lecture	german
<b>Literature</b>			
Ohm, Lüke: Signalübertragung, Springer-Verlag, ISBN 3-540-67768-2 Reimers: Digitale Fernsehtechnik, 2. Aufl., ISBN 3-540-60945-8			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

<b>Title</b>	Mobile Communications		
<b>Number</b>	4213400	<b>Module version</b>	V2
<b>Shorttext</b>	INF-KM-40	<b>Language</b>	german
<b>Frequency of offer</b>		<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	Institut für Betriebssysteme und Rechnerverbund
<b>Hours per Week / ECTS</b>	0 / 5,0	<b>Module owner</b>	
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	1 graded work: Written exam (90 minutes) or oral exam (20 minutes) or Take-Home-Exam.		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Technical fundamentals of mobile communications</li> <li>- Media access</li> <li>- Wireless Telecommunications Systems</li> <li>- Wireless LANs</li> <li>- Network layer aspects</li> <li>- Transport Layer Aspects</li> <li>- Mobility support</li> </ul>			
<b>Objective qualification</b>			
On completion of the module, students will be familiar with the fundamental challenges and solutions in mobile communications.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Jochen Schiller: Mobilkommunikation, Pearson Studium. 2003</li> </ul> <p>Siehe auch Aktualisierung auf der Webseite der Lehrveranstaltung</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

Mobile Communications	4,0	Lecture/Exercise	english german
<b>Literature</b>			
J. Schiller: Mobilkommunikation - Techniken für das allgegenwärtige Internet, 2. Auflage, Addison-Wesley 2003			
	1,0	Exercise	english german

<b>Title</b>	Hardware Software Systems		
<b>Number</b>	4211270	<b>Module version</b>	V2
<b>Shorttext</b>	INF-EIS-27	<b>Language</b>	
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Carl-Friedrich-Gauß-Fakultät
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Guillermo Payá Vayá
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	1 graded work: Written exam (90 minutes) or oral exam (30 minutes) or Take-Home-Exam.		
<b>Course achievement</b>			
<b>Contents</b>			
<b>Objective qualification</b>			
<b>Literature</b>			
<p>- Ming-Bo Lin: Introduction to VLSI Systems. A logic, circuit and system perspective. 1st edition. CRC Press, 2012.</p> <p>- Douglas J. Smith: HDL Chip Design: A Practical Guide for Designing, Synthesizing, and Simulating ASICs and FPGAs Using VHDL Or Verilog. Doone Publications,1998.</p> <p>- Brian Bailey, Grant Martin: ESL Models and their Application. Electronic System Level Design and Verification in Practice.Springer Verlag, 2010.</p> <p>- Skript und multimediale Lernprogramme</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

Hardware-Software-Systems	2,0	Lecture/Exercise	german
<b>Literature</b>			
<p>- Ming-Bo Lin: Introduction to VLSI Systems. A logic, circuit and system perspective. 1st edition. CRC Press, 2012. - Douglas J. Smith: HDL Chip Design: A Practical Guide for Designing, Synthesizing, and Simulating ASICs and FPGAs Using VHDL Or Verilog. Doone Publications, 1998. - Brian Bailey, Grant Martin: ESL Models and their Application. Electronic System Level Design and Verification in Practice. Springer Verlag, 2010. - Skript und multimediale Lernprogramme</p>			
	2,0	Exercise	german

<b>Title</b>	Digital Signal Transmission and Computational Experiments		
<b>Number</b>	2424670	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-67	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	8 / 10,0	<b>Module owner</b>	Prof. Dr. Eduard Jorswieck
<b>Workload (h)</b>	300		
<b>Class attendance (h)</b>	112	<b>Self studying (h)</b>	188
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min) or written exam (180 min)		
<b>Course achievement</b>	Colloquium or lab minutes		
<b>Contents</b>			
<p>Part I:</p> <ul style="list-style-type: none"> <li>- Deterministic signals in LTI systems</li> <li>- Fourier transform</li> <li>- Discrete signals and systems</li> <li>- Correlation function of deterministic signals</li> <li>- System theory of low-pass and band-pass systems</li> </ul> <p>Part II:</p> <ul style="list-style-type: none"> <li>- Statistical signal processing</li> <li>- Multiplexing</li> <li>- Binary transmission with low-pass signals</li> <li>- Binary transmission with band-pass signals</li> <li>- Digital modulation</li> </ul>			
<b>Objective qualification</b>			
The students describe signal processing systems by their impulse response or transfer function. They know the fundamental principles of digital communications systems. Practical knowledge and examples in computational experiments.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Ohm, Lüke: Signalübertragung, Springer-Verlag, ISBN 3-540-67768-2</li> <li>- U. Reimers: Digitale Fernsehtechnik, 2.Aufl. 1997, ISBN 3-540-60945-8</li> </ul>			
<b>Remark</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Ohm, Lüke: Signalübertragung, Springer-Verlag, ISBN 3-540-67768-2 Reimers: Digitale Fernsehtechnik, 2. Aufl., ISBN 3-540-60945-8			
	2,0	Laboratory	german
<b>Literature</b>			
siehe Vorlesung			
	2,0	Lecture	german
<b>Literature</b>			
Ohm, Lüke: Signalübertragung, Springer-Verlag, ISBN 3-540-67768-2 Reimers: Digitale Fernsehtechnik, 2. Aufl., ISBN 3-540-60945-8			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

**Optional Subjects Energy Systems and Drive Technologies/ Powertrain**

<b>Title</b>	Identification of Dynamic Systems		
<b>Number</b>	2412380	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-38	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Marcus Grobe
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>	Lecture "Fundamentals of Control Engineering"		
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
Statistical basics, closed-loop identification, excitation signals for identification, least square method, bias-free estimation, method of instrumental variables, Box-Jenkins, maximum likelihood method, Cor-LS method.			
<b>Objective qualification</b>			
After completing the module, students will be able to determine model parameters for linear systems using statistical methods (identification) and evaluate algorithms for their determination.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- E. Hänsler: Statistische Signale</li> <li>- Grundlagen und Anwendungen, Springer-Verlag, ISBN: 978-3540416449</li> <li>- R. Isermann: Identifikation dynamischer Systeme I &amp; II, Springer-Verlag, ISBN: 978-3540549246 &amp; 978-3540554684</li> <li>- L. Ljung: System Identification, Prentice Hall, ISBN: 978-0136566953</li> <li>- W. Leonhard: Statistische Analyse linearer Regelsysteme, Teubner-Verlag, ISBN: 978-3519020462</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Advanced Control Engineering		
<b>Number</b>	2412390	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-39	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>	Prerequisite: Lecture "Fundamentals of Control Engineering"		
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes), depending on number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Continuation and application of linear control theory, meshed control loops, multivariable control, simple nonlinear control systems: two- and three-step controllers, state space equations, state space control, state space, description function, stability criteria for nonlinear control systems.			
<b>Objective qualification</b>			
After completing the module, students are able to apply advanced control engineering knowledge in the area of multivariable control of linear systems in state space (state controller, observer, disturbance compensation).			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- J. Lunze: Regelungstechnik 2, Springer-Verlag, ISBN: 978-3540784623</li> <li>- O. Föllinger: Nichtlineare Regelungen 1 &amp; 2, Hüthig-Verlag, ISBN: 978-3486245271 &amp; 978-3486225037</li> <li>- W. Leonhard: Einführung in die Regelungstechnik, Vieweg-Verlag, ISBN: 978-3528535841</li> </ul>			
<b>Remark</b>			
Prerequisite: Lecture "Fundamentals of Control Engineering"			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Exercise	german
	2,0	Lecture	german

<b>Title</b>	High-Voltage Safety in the Motor Vehicle		
<b>Number</b>	2412650	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-65	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes)		
<b>Course achievement</b>	Lab course		
<b>Contents</b>			
<p>The contents result primarily from the qualification measures QM2b+3a of the German Legal Accident Insurance (DGUV) Information 200-005 for work on vehicles with high-voltage systems. Electrotechnical work in a voltage-free state on non-HV intrinsically safe systems level 2 according to DGUV Information 200-005" and working under voltage and near touchable live parts Level 3 according to DGUV Information 200-005".</p>			
<b>Objective qualification</b>			
<p>After completing this module, the students have basic knowledge on HV safety resulting from the qualification measures QM2b+3a of DGUV Information 200-005 for work on vehicles with high-voltage systems. They achieved in particular, an understanding of the electrical hazards associated with the use of HV systems in vehicles. The students will understand and be able to apply appropriate processes guaranteeing safety and health in electrotechnical work under high voltage. The qualification is documented with the successful participation in the practical exercises as well as a proof of the acquired skills and knowledge by an examination.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Folien zum Seminarinhalt</li> <li>• Arbeitsblätter</li> <li>• Gesetzliche Unterlagen wie:</li> <li>• DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686)</li> <li>• ECE R 100</li> <li>• DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)</li> </ul>			
<b>Remark</b>			
<p>Compulsory attendance at the seminar: Participation in the seminar is required and recorded by attendance list and signature. It will be carried out short tests on the individual contents in the event.</p>			

The attendance as well as the tests in the seminar are mandatory so that the lecturer is able to assess the individual level of knowledge and training of the participants as well as their personal suitability before the students will perform experiments of their own.

Limitation of the number of participants:

The number of participants is limited to 20 people so that the required practical part is sufficiently can be mediated.

Additional note:

The practical exercises take place at the institute's training stands. Training contents include measurements of the output voltages on a frequency converter and the replacement of battery cells. These works will be performed under high voltage. If they are not carried out in accordance with the regulations and with the necessary knowledge, they are life threatening. It is therefore important to reduce the risk for students. The lecturer must therefore obtain an overview of the level of knowledge and training of the participants as well as their personal suitability in advance. This goal is achieved through compulsory attendance and tests in the seminar.



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Seminar	german
<b>Literature</b>			
Folien zum Seminarinhalt Arbeitsblätter Gesetzliche Unterlagen wie: DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686) ECE R 100 DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)			
	1,0	Internship	german
<b>Literature</b>			
Folien zum Seminarinhalt Arbeitsblätter Gesetzliche Unterlagen wie: DGUV Information 200-005 (bisherige Bezeichnung: BGI/GUV-I 8686) ECE R 100 DGUV Regel 103-011 (bisherige Bezeichnung: BGR A3)			

<b>Title</b>	Electrical Machines and Drives		
<b>Number</b>	2414180	<b>Module version</b>	
<b>Shorttext</b>	ET-IMAB-18	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Maschinen, Antriebe und Bahnen
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Henke
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Speed and torque control of direct current and three-phase drives with power electronic control circuits</li> <li>- Operating behaviour of permanent magnet and salient pole synchronous machines</li> <li>- Modelling of electrical machines and drives</li> <li>- Design and control of magnetic bearings</li> </ul>			
<b>Objective qualification</b>			
After completing the Electrical Drives module, students will have an overview of the functions of the most important DC and most important direct current and rotating field machines. The in-depth fundamentals enable the assessment of existing motor and generator drives as well as the design of simple drive systems for industry and mobile applications.			
<b>Literature</b>			
Binder, Elektrische Maschinen und Antriebe: Grundlagen, Betriebsverhalten, Springer Schröder D., Elektrische Antriebe Grundlagen, Springer Hofmann W., Elektrische Maschinen, Pearson Hagl, Elektrische Antriebstechnik, Hanser			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

---

	2,0	Exercise	german
<b>Literature</b>			
Skript			
	2,0	Lecture	german
<b>Literature</b>			
Skript, H.O. Seinsch, Ausgleichsvorgänge bei elektrischen Antrieben, Teubner Verlag, Stuttgart			

<b>Title</b>	Basic Circuits of Power Electronics		
<b>Number</b>	2414190	<b>Module version</b>	
<b>Shorttext</b>	ET-IMAB-19	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Maschinen, Antriebe und Bahnen
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Regine Mallwitz
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Components of power electronics</li> <li>• Simulation of power electronics</li> <li>• Dimensioning of chokes and transformers</li> <li>• Functionality and design of DC converters and switching power supplies</li> <li>• Control and protective circuitry of power semiconductors</li> <li>• Power loss and cooling of power semiconductors</li> </ul>			
<b>Objective qualification</b>			
After completing the module, students will have acquired basic knowledge of the structure, function, application and design of passive components in power electronics. They will be able to independently design and dimension complete power electronics circuit arrangements.			
<b>Literature</b>			
Schaltnetzteile und ihre Peripherie, Ulrich Schlienz, Vieweg-Verlag			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Exercise	german
	2,0	Lecture	german
<b>Literature</b>			
Jürgen Meins: "Elektromechnik", B.G. Teubner Verlag 1997 Schaltnetzteile und ihre Peripherie, Ulrich Schlienz, Vieweg-Verlag			

<b>Title</b>	Electromagnetic Compatibility		
<b>Number</b>	2419120	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Dr. Harald Spieker
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Terms and definitions of EMC</li> <li>• Sources of interference and disturbance variables, immunity of susceptible devices #</li> <li>• Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference #</li> <li>• Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection #</li> <li>• Legal basis, product liability, standardization #</li> <li>• EMC test engineering #</li> <li>• Electromagnetic compatibility of biological systems</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able to assess the EMC product safety by failure mechanisms.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- Joachim Franz, EMV – Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X</li> <li>- Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1</li> <li>- Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Either this module or "Electromagnetic Compatibility with Seminar" can be selected.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electromagnetic Compatibility	2,0	Lecture	german
Electromagnetic Compatibility	1,0	Exercise	german

<b>Title</b>	Electrical Distribution Systems Technology		
<b>Number</b>	2423300	<b>Module version</b>	
<b>Shorttext</b>	ET-HTEE-30	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	elenia Institut für Hochspannungstechnik und Energiesysteme
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Bernd Engel
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Electrical Grid and Grid structures</li> <li>• Basic terms, energy history, future</li> <li>• Cable and overhead line</li> <li>• Transformer</li> <li>• Substations and Control rooms</li> <li>• Grid safety &amp; security</li> <li>• Grid planning, calculation and AI</li> <li>• Grid financing and grid fees</li> <li>• Innovative grid operation using the example of medium and low voltage grids</li> <li>• Active power management in distribution grids</li> </ul>			
<b>Objective qualification</b>			
<p>After successfully completing the module, students will have basic knowledge of technologies that are relevant to the distribution of electrical energy now and in the future. They are informed about current and future developments in electrical energy distribution networks and can formulate existing challenges. They are able to analyse and assess technologies, components and systems and to design and dimension them in principle.</p>			
<b>Literature</b>			
<p>Elektrische Energieverteilung – Flosdorff, Hilgarth – Vieweg + Teubner          Elektrische Energieversorgung – Heuck, Dettmann, Schulz – SpringerVieweg          Taschenbuch der elektrischen Energietechnik – Schufft – Hanser          Elektrische Anlagentechnik – Knies, Schierack – Hanser          Elektroenergiesysteme – Schwab – Springer</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	3,0	Lecture	german
<b>Literature</b>			
Elektrische Energieverteilung; Flosdorff, Hilgarth; Vieweg + Teubner Elektrische Energieversorgung; Heuck, Dettmann, Schulz; SpringerVieweg Taschenbuch der elektrischen Energietechnik; Schufft; Hanser Elektrische Anlagentechnik; Knies, Schierack; Hanser Elektroenergiesysteme; Schwab; Springer			
	1,0	Exercise	german
<b>Literature</b>			
Elektrische Energieverteilung; Flosdorff, Hilgarth; Vieweg + Teubner Elektrische Energieversorgung; Heuck, Dettmann, Schulz; SpringerVieweg Taschenbuch der elektrischen Energietechnik; Schufft; Hanser Elektrische Anlagentechnik; Knies, Schierack; Hanser Elektroenergiesysteme; Schwab; Springer			

<b>Title</b>	Electrical Transmission Systems Technology		
<b>Number</b>	2423420	<b>Module version</b>	
<b>Shorttext</b>	ET-HTEE-42	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	elenia Institut für Hochspannungstechnik und Energiesysteme
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Michael Kurrat
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• High-Voltage Technologies</li> <li>• Smart Grids</li> <li>• High-Voltage Direct Current Transmission</li> <li>• High-Temperature Superconductors</li> </ul>			
<b>Objective qualification</b>			
After successful completion of the course, students have a fundamental understanding of latest and future technologies that are relevant for the transmission of electrical energy. They are informed about current and future developments regarding transmission grids and are able to formulate existing challenges. Students are also able to analyze, assess and design technologies, components, and systems on a fundamental level.			
<b>Literature</b>			
Hochspannungstechnik, A. Küchler, Springer Verlag Elektroenergiesysteme, A. Schwab, Springerverlag Elektrische Energieversorgung, K. Heuck, Vieweg Grundkurs Leistungselektronik, J. Specovius, Vieweg+Teubner Verlag Supraleitung, W. Buckel, VCH			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Bachelor's module			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Exercise	german
	2,0	Lecture	german

<b>Title</b>	Energy Economy and Market Integration of Renewables		
<b>Number</b>	2423460	<b>Module version</b>	
<b>Shorttext</b>	ET-HTEE-42	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	elenia Institut für Hochspannungstechnik und Energiesysteme
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Bernd Engel
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
1. energy economics 2. energy policy 3. laws and subsidy systems 4. markets (electricity market 2.0, balancing power market) 5. direct marketing / balancing group management 6. virtual power plant 7. large-scale storage			
<b>Objective qualification</b>			
On completion of the module, students will have acquired knowledge of the energy industry in Germany. They will be able to evaluate and assess current developments in the markets. New technologies and research insights are integrated.			
<b>Literature</b>			
Marcel Linnemann: Energiewirtschaft für (Quer-)Einsteiger Tim Wawer: Elektrizitätswirtschaft			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Electrochemical storages embedded in on-board power systems		
<b>Number</b>	2419000000	<b>Module version</b>	
<b>Shorttext</b>		<b>Language</b>	english
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Michael Terörde
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam, 30 minutes or written exam, 90 minutes		
<b>Course achievement</b>			
<b>Contents</b>			
<p><b>On-board power system topics:</b> On-board power networks of aircraft, automobiles, ships and satellites, protection elements of on-board networks, calculation of simple circuit diagrams, network shapes, simulations of energy systems, power electronic switches in on-board networks.</p> <p><b>Electrochemical storage systems:</b> batteries, fuel cells, hydrogen as an energy carrier, super capacitors, power to gas concept, thermal behavior and current and voltage characteristics of the storage systems</p>			
<b>Objective qualification</b>			
<p>After completing the module, students will be able to evaluate the integration of different electrochemical energy storage systems in different types of vehicles. They will be able to derive simple electrical equivalent circuit diagrams from vehicle electrical system circuit diagrams and use them to perform calculations with regard to electrical parameters. They will be able to explain details of the design and operation of fuel cells, batteries and double-layer capacitors.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Elective areas: Energy Systems and Drive Technologies/Powertrain, Autonomous Intelligent Systems			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electrochemical storages embedded in on-board power systems	2,0	Lecture	english
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			
Electrochemical storages embedded in on-board power systems	1,0	Exercise	english
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Dicks, Andrew L., and David AJ Rand. Fuel cell systems explained. John Wiley &amp; Sons, 2018.</li> <li>• Hirose, K., Handbook of hydrogen storage: new materials for future energy storage. 2010: John Wiley &amp; Sons</li> </ul>			

<b>Title</b>	Design and calculation of DC systems		
<b>Number</b>	2423510	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-39	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	elenia Institut für Hochspannungstechnik und Energiesysteme
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Michael Kurrat
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 minutes) or development and documentation of a computer/software program		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Calculation and design of DC-networks</li> <li>- Operation of DC-networks</li> <li>- Fault detection and localization</li> <li>- Plant engineering</li> <li>- Components for power generation, distribution and storage</li> <li>- Industrial networks, isolated networks, on-board networks</li> </ul>			
<b>Objective qualification</b>			
<p>After successful completion of the module, students will have a basic knowledge of the structure and function of DC- systems. They are familiar with the hazards and the necessary safety measures and regulations in DC-networks. Industrial networks, data centers and on-board networks are typical applications. By means of experiments and simulations, the students learn practical knowledge.</p>			
<b>Literature</b>			
<p>HVDC Technology: An Introduction (Michael Kurrat, TU Braunschweig)          HVDC Grids (D. van Hertem)          Microgrid: Dynamics and Control (H. Bevrani)          Multi-terminal Direct-Current Grids (N.R. Chaudhuri)          Urban DC Microgrid: Intelligent Control and Power Flow Optimization          Fault detection and diagnosis in engineering systems          Fault location on power networks (M.M. Saha)          Elektrische Messtechnik: Analoge, digitale und computergestützte Verfahren (R. Lerch)</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<p>HVDC Technology: An Introduction (Michael Kurrat, TU Braunschweig) HVDC Grids (D. van Hertem) Microgrid: Dynamics and Control (H. Bevrani) Multi-terminal Direct-Current Grids (N.R. Chaudhuri) Urban DC Microgrid: Intelligent Control and Power Flow Optimization Fault detection and diagnosis in engineering systems Fault location on power networks (M.M. Saha) Elektrische Messtechnik: Analoge, digitale und computergestützte Verfahren (R. Lerch)</p>			
	2,0	Exercise	german
<b>Literature</b>			
<p>HVDC Technology: An Introduction (Michael Kurrat, TU Braunschweig) HVDC Grids (D. van Hertem) Microgrid: Dynamics and Control (H. Bevrani) Multi-terminal Direct-Current Grids (N.R. Chaudhuri) Urban DC Microgrid: Intelligent Control and Power Flow Optimization ( Fault detection and diagnosis in engineering systems Fault location on power networks (M.M. Saha) Elektrische Messtechnik: Analoge, digitale und computergestützte Verfahren (R. Lerch)</p>			

**Optional Subjects Metrology and Measurement Technology**

Measurement Electronics			
<b>Number</b>	2411230	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-23	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	78
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Measuring amplifiers with transistors and OPVs Electronic switches Source circuits Measuring transducers Analogue filter circuits Treatment of interference signals and noise Correlation analysis Measurement converters (A/D and D/A) Measuring device buses Time measurement Oscilloscopes and trigger circuits			
<b>Objective qualification</b>			
After completing the 'Measurement Electronics' module, students will have an overview of circuit technology and measurement methods in measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- A multi-media CD ROM with script and exercises is available for the lecture</li> <li>- Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827</li> <li>- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926</li> <li>- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263</li> <li>- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175</li> <li>- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Measurement Electronics	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			
Measurement Electronics	1,0	Exercise	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			

<b>Title</b>	Measurement Electronics with Experiments		
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

Measurement Electronics	2,0	Lecture	german
-------------------------	-----	---------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Measurement Electronics	1,0	Exercise	german
-------------------------	-----	----------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Electronics measurement internship	3,0	Internship	german
------------------------------------	-----	------------	--------

**Literature**

Internship script

<b>Title</b>	Advanced Control Engineering		
<b>Number</b>	2412390	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-39	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>	Prerequisite: Lecture "Fundamentals of Control Engineering"		
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes), depending on number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Continuation and application of linear control theory, meshed control loops, multivariable control, simple nonlinear control systems: two- and three-step controllers, state space equations, state space control, state space, description function, stability criteria for nonlinear control systems.			
<b>Objective qualification</b>			
After completing the module, students are able to apply advanced control engineering knowledge in the area of multivariable control of linear systems in state space (state controller, observer, disturbance compensation).			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- J. Lunze: Regelungstechnik 2, Springer-Verlag, ISBN: 978-3540784623</li> <li>- O. Föllinger: Nichtlineare Regelungen 1 &amp; 2, Hüthig-Verlag, ISBN: 978-3486245271 &amp; 978-3486225037</li> <li>- W. Leonhard: Einführung in die Regelungstechnik, Vieweg-Verlag, ISBN: 978-3528535841</li> </ul>			
<b>Remark</b>			
Prerequisite: Lecture "Fundamentals of Control Engineering"			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Exercise	german
	2,0	Lecture	german

<b>Title</b>	Data Bus Systems		
<b>Number</b>	2412400	<b>Module version</b>	
<b>Shorttext</b>	ET-IFR-40	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Regelungstechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Markus Maurer
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 minutes) or written exam (60 minutes), depending on the number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Bus architectures and access methods</li> <li>- Physical layers</li> <li>- Network and transport layer according to ISO layer model using the example of the OSEK standard for Network communication and management</li> <li>- LIN, CAN, TTP, FlexRay, MOST and Bluetooth</li> <li>- Interbus, Profibus, HART, ASI</li> <li>- Procedure for the selection of a suitable data bus system for a selected application</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students have basic knowledge of architectures and protocol standards of data bus systems in modern motor vehicles as well as industrial plants. They are familiar with functional principles and properties of commonly used data buses from various application areas. The fundamentals learned enable them to independently design or analyze and evaluate networked systems.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Zimmermann, Schmidgall, Bussysteme in der Fahrzeugtechnik, Vieweg Verlag 2006, ISBN 3-8348-0166-6</li> <li>- G. Schnell, B. Wiedemann, Bussysteme in der Automatisierungs- und Prozesstechnik, Vieweg Verlag 2006, ISBN 3-8348-0045-7</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
both lectures and exercises must be attended			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Foliensammlung</li> <li>- Literaturempfehlungen in der Vorlesung</li> <li>- Etschberger, Controller-Area-Network, Hanser Verlag</li> <li>- Grzempa: LIN-Bus, Franzis Verlag</li> <li>- Rausch: Flexray, Hanser Verlag</li> <li>- Schäuffele: Automotive Software Engineering, Vieweg Verlag</li> <li>- Zimmermann: Bussysteme in der Fahrzeugtechnik, Vieweg Verlag</li> <li>- Schnell, Wiedemann: Bussysteme in der Automatisierungs- und Prozesstechnik</li> </ul>			
	1,0	Exercise	german

<b>Title</b>	Lighting Engineering		
<b>Number</b>	2413320	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-32	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Andreas Waag
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 min) or written exam (90 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources, luminaires and the relevant DIN standards. Special focus: Lighting technology and lighting technology for the automotive sector</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and design of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> <li>• Applications (lighting technology, Automotive Lighting)</li> </ul> <p>[Lighting technology (V)] The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources and luminaires. After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.</p> <p>[Lighting technology (Ü)]</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and construction of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> </ul>			
<b>Objective qualification</b>			

After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.

**Literature**

Lecture notes and slides

Hans-Jürgen Hentschel (Hrsg.): Licht und Beleuchtung; Hüthig 2002, ISBN 3-7785-2817-3

Horst Lange (Hrsg.): Handbuch für Beleuchtung; Landsberg 2007, ISBN 978-3-609-75390-4



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzsript Hans-Jürgen Hentschel: Licht und Beleuchtung Horst Lange: Handbuch für Beleuchtung			
	1,0	Exercise	german

<b>Title</b>	Semiconductor Metrology		
<b>Number</b>	2413330	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-33	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Erwin Peiner
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Crystal-structure analysis, X-ray diffraction</li> <li>- Lattice defects</li> <li>- Epitaxial layers, nanostructures, lattice mismatch</li> <li>- Microscopy (light, electrons, scanning probes), imaging modes, analytical electron microscopy</li> <li>- Band structure, band gap, excitation spectroscopy, spatially resolved luminescence, effective mass</li> <li>- Electrical transport properties, piezoresistive effect</li> <li>- Charge carrier concentration and mobility, Hall method, CV method</li> <li>- Optical absorption, Fourier transform spectroscopy</li> <li>- Impurities and defects, chemical analysis, deep traps</li> <li>- Minority carrier lifetime, diffusion length</li> <li>- Metal-semiconductor junction, Schottky contact, Ohmic contact, sheet resistance</li> <li>- Oxide layers, ellipsometry</li> <li>- Device characteristics</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module semiconductor characterization, the students will have</p> <ul style="list-style-type: none"> <li>- a basic understanding of the most important methods for characterizing semiconductor materials</li> <li>- the ability to select appropriate quality control procedures in the manufacture of semiconductor devices</li> <li>- in-depth knowledge and practical experience in the analysis and evaluation of measurement results with bulk crystals, layers as well as micro- and nanostructured devices</li> </ul>			
<b>Literature</b>			
<p>K. Kopitzki: Einführung in die Festkörperphysik (Teubner, Stuttgart, 1989) ISBN: 3-519-13083-1  H. Alexander: Physikalische Grundlagen der Elektronenmikroskopie (Teubner, Stuttgart, 1997) ISBN: 3-519-03221-X  W. Prost: Technologie der III/V-Halbleiter: III/V-Heterostrukturen und elektronische Höchstfrequenz-Bauelemente (Springer, Berlin, 1997) ISBN:3-540-62804-5  W. Schäfer, G. Terlecki: Halbleiterprüfung (Hüthig, Heidelberg, 1986) ISBN: 3-778-51007-X</p>			

D. K. Schroder: Semiconductor Material and Device Characterization (Wiley, New York, 1990) ISBN: 0-471-51104-8  
 R. Wiesendanger (Hrsg): Scanning Probe Microscopy - Analytical Methods (Springer, Berlin, 1998) ISBN: 3-540-63815-6  
 Script and exercise materials will be handed out.

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
K. Kopitzki: Einführung in die Festkörperphysik (Teubner, Stuttgart, 1989) H. Alexander: Physikalische Grundlagen der Elektronenmikroskopie (Teubner, Stuttgart, 1997) W. Prost: Technologie der III/V-Halbleiter: III/V-Heterostrukturen und elektronische Höchstfrequenz-Bauelemente (Springer, Berlin, 1997) W. Schäfer, G. Terlecki: Halbleiterprüfung (Hüthig, Heidelberg, 1986) D. K. Schroder: Semiconductor Material and Device Characterization (Wiley, New York, 1990) R. Wiesendanger (Hrsg): Scanning Probe Microscopy - Analytical Methods (Springer, Berlin, 1998)			
	1,0	Exercise	german
<b>Literature</b>			
Übungsunterlagen und Vorlesungsskript werden verteilt.			

<b>Title</b>	Nano- and Bioelectronic System		
<b>Number</b>	2413560	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-56	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tobias Voß
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 minutes) or written exam (120 minutes), depending on number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
<p>Introduction to nanotechnology  growth, nanostructuring and characterization processes and tools (lithography, microscopy, raster probe technique, spectroscopy, nanotubes, nanowires, nanoparticles, hybrid nanostructures  bio-organic functionalization of surfaces (Langmuir-Blodgett, self-assembled monolayers on metals and semiconductors)  semiconductor nano- and biosensors based on different inorganic and organic nanomaterials  hybrid nanostructures for optoelectronics</p>			
<b>Objective qualification</b>			
<p>After completion of the module Nano- and Bioelectronic Systems, the students possess</p> <ul style="list-style-type: none"> <li>- a basic understanding of the most important techniques for the preparation and characterization of inorganic and hybrid nanoelectronic systems (nanoparticles, nanotubes, nanowires, quantum well structures)</li> <li>- the ability to combine acquired fundamental knowledge to understand and evaluate advanced semiconductor-based nano and biosensors as well as nanoscale hybrid optoelectronic devices</li> </ul>			
<b>Literature</b>			
<p>"Nanoelectronics and Information Technology. Advanced Electronic Materials and Novel Devices", R. Waser (Ed.), Wiley-VCH, 2nd Ed. (2005): ISBN-13: 978-3527405428  "Springer Handbook of Nanotechnology", B. Bhushan (Ed.), Springer, 2nd. Ed. (2006): ISBN-13: 978-3540298557</p>			
<b>Remark</b>			
primarily master module			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
"Nanoelectronics and Information Technology. Advanced Electronic Materials and Novel Devices", R. Waser (Ed.), Wiley-VCH (2003) "Springer Handbook of Nanotechnology", B. Bhushan (Ed.), Springer (2004)			
	1,0	Exercise	german
<b>Literature</b>			
"Nanoelectronics and Information Technology. Advanced Electronic Materials and Novel Devices", R. Waser (Ed.), Wiley-VCH (2003) "Springer Handbook of Nanotechnology", B. Bhushan (Ed.), Springer (2004)			

<b>Title</b>	Lighting Engineering		
<b>Number</b>	2413590	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-59	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	5 / 7,0	<b>Module owner</b>	Prof. Dr. Andreas Waag
<b>Workload (h)</b>	210		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	140
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 min) or written exam (90 min)		
<b>Course achievement</b>	Lab work		
<b>Contents</b>			
<p>The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources, luminaires and the relevant DIN standards. Special focus: Lighting technology and lighting technology for the automotive sector</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and design of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> <li>• Applications (lighting technology, Automotive Lighting)</li> </ul> <p>[Lighting technology (V)] The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources and luminaires. After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.</p> <p>[Lighting technology (Ü)]</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and construction of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> </ul>			
<b>Objective qualification</b>			

After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.

**Literature**

Lecture notes and slides  
 Hans-Jürgen Hentschel (Hrsg.): Licht und Beleuchtung; Hüthig 2002, ISBN 3-7785-2817-3  
 Horst Lange (Hrsg.): Handbuch für Beleuchtung; Landsberg 2007, ISBN 978-3-609-75390-4



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzsript Hans-Jürgen Hentschel: Licht und Beleuchtung Horst Lange: Handbuch für Beleuchtung			
	1,0	Exercise	german
Laboratory practical course indoor lighting	2,0	Laboratory	german
<b>Literature</b>			
DIN 5035-5			

<b>Title</b>	Electromagnetic Compatibility		
<b>Number</b>	2419120	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Dr. Harald Spieker
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Terms and definitions of EMC</li> <li>• Sources of interference and disturbance variables, immunity of susceptible devices #</li> <li>• Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference #</li> <li>• Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection #</li> <li>• Legal basis, product liability, standardization #</li> <li>• EMC test engineering #</li> <li>• Electromagnetic compatibility of biological systems</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able assess the EMC product safety by failure mechanisms.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- Joachim Franz, EMV – Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X</li> <li>- Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1</li> <li>- Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Either this module or "Electromagnetic Compatibility with Seminar" can be selected.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electromagnetic Compatibility	2,0	Lecture	german
Electromagnetic Compatibility	1,0	Exercise	german

<b>Title</b>	Fundamentals of Digital Signal Processing		
<b>Number</b>	2424480	<b>Module version</b>	
<b>Shorttext</b>	ET-NT-48	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Nachrichtentechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tim Fingscheidt
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Discrete-time signals and systems #</li> <li>- Fourier transforms #</li> <li>- Z-transforms and applications #</li> <li>- Discrete-time IIR filter design #</li> <li>- Discrete-time FIR filter design #</li> <li>- Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) #</li> <li>- Basics of multi-rate processing and filter banks</li> </ul>			
<b>Objective qualification</b>			
After completing this module, students will have basic knowledge on the tools of digital signal processing in the time and frequency domain and can apply these tools to corresponding problems.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Zeitdiskrete Signalverarbeitung" , Pearson Verlag, 2004</li> <li>- K.D. Kammeyer, K. Kroschel: "Digitale Signalverarbeitung" , Teubner Verlag, 2002</li> <li>- A.V. Oppenheim, R.W. Schafer, J.R. Buck: "Discrete Time Signal Processing" , Prentice-Hall, 2004</li> <li>- H.-W. Schüßler: "Digitale Signalverarbeitung 1" , Springer Verlag, 1994</li> </ul>			
<b>Remark</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Zeitdiskrete Signalverarbeitung, Pearson Studium, 2004</li> <li>• K. D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung, Teubner Verlag, 2002</li> <li>• A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete Time Signal Processing, Prentice Hall, 2004</li> <li>• H.-W. Schüßler: Digitale Signalverarbeitung, Springer Verlag, 1994</li> </ul>			
	1,0	Exercise	german
<b>Literature</b>			
siehe Vorlesung			

Measurement Electronics with Experiments			
<b>Title</b>	Measurement Electronics with Experiments		
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	english
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

Measurement Electronics	2,0	Lecture	german
-------------------------	-----	---------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Measurement Electronics	1,0	Exercise	german
-------------------------	-----	----------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Electronics measurement internship	3,0	Internship	german
------------------------------------	-----	------------	--------

**Literature**

Internship script

**Optional Subjects Photonics and Quantum Technologies**

<b>Title</b>	Measurement Electronics		
<b>Number</b>	2411230	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-23	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	78
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>			
<b>Contents</b>			
Measuring amplifiers with transistors and OPVs Electronic switches Source circuits Measuring transducers Analogue filter circuits Treatment of interference signals and noise Correlation analysis Measurement converters (A/D and D/A) Measuring device buses Time measurement Oscilloscopes and trigger circuits			
<b>Objective qualification</b>			
After completing the 'Measurement Electronics' module, students will have an overview of circuit technology and measurement methods in measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- A multi-media CD ROM with script and exercises is available for the lecture</li> <li>- Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827</li> <li>- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926</li> <li>- Dieter Nührmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263</li> <li>- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175</li> <li>- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Measurement Electronics	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			
Measurement Electronics	1,0	Exercise	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>• Allan R. Hambley #Electronics#, Prentice Hall</li> <li>• U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>• Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>• P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>• Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			

<b>Title</b>	Measurement Electronics with Experiments		
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Measurement Electronics	2,0	Lecture	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>Allan R. Hambley #Electronics#, Prentice Hall</li> <li>U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			
Measurement Electronics	1,0	Exercise	german
<b>Literature</b>			
<ul style="list-style-type: none"> <li>Allan R. Hambley #Electronics#, Prentice Hall</li> <li>U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002</li> <li>Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag</li> <li>P. Horowitz #The Art of Electronics#, Cambridge Univ. Press</li> <li>Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996</li> </ul>			
Electronics measurement internship	3,0	Internship	german
<b>Literature</b>			
Internship script			

<b>Title</b>	Integrated Circuits		
<b>Number</b>	2413280	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-28	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Vadim Issakov
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (20 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>The module provides an overview of the operation, design, and technology of integrated electronic circuits in microelectronics.</p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Basic digital circuits</li> <li>• MOS and CMOS</li> <li>• Silicon wafer manufacturing</li> <li>• MOSFET process technology</li> <li>• Nanolithography</li> <li>• Etching techniques and oxidation</li> <li>• Design automation, design rules, and assembly techniques</li> <li>• Back-end technologies</li> <li>• Modern developments: Memory technologies</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module, students will be able to understand integrated circuits, their structure and mode of operation and design simple integrated circuits themselves. A further focus is on the methods of nanotechnology.</p>			
<b>Literature</b>			
<p>Lecture slides and short script  J.M.Rabaey, A.Chandrakasan, B. Nikolic, Digital Integrated Circuits  Prentice Hall Electronics and VLSI Series, 2002 ISBN: 8120322576  A. Schlachetzki, Integrierte Schaltungen, Teubner, 1978, (as copy at IHT) ISBN: 3-519-03070-5  D. Widmann, H. Mader, H. Friedrich, Technologie Hochintegrierte Schaltungen, Springer, 1996  ISBN:3540593578  W. Prost, Technologie der III/V Halbleiter, Springer, 1997 ISBN: 3540628045</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzschrift K.-H. Cordes, A. Waag, N. Heuck : Integrierte Schaltungen; Pearson Studium, 2010 J.M.Rabaey, A.Chandrakasan, B. Nikolic, Digital Integrated Circuits Prentice Hall Electronics and VLSI Series, 2003, 1996 A. Schlachetzki, Integrierte Schaltungen, Teubner, 1978, (als Kopie im IHT) D. Widmann, H. Mader, H. Friedrich, Technologie Hochintegrierte Schaltungen, Springer, 1996 W. Probst, Technologie der III/V # Halbleiter, Springer, 1997			
	1,0	Exercise	german
<b>Literature</b>			
K.-H. Cordes, A. Waag, N. Heuck : Integrierte Schaltungen; Pearson Studium, 2010			

<b>Title</b>	Lighting Engineering		
<b>Number</b>	2413320	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-32	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Andreas Waag
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 min) or written exam (90 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<p>The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources, luminaires and the relevant DIN standards. Special focus: Lighting technology and lighting technology for the automotive sector</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and design of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> <li>• Applications (lighting technology, Automotive Lighting)</li> </ul> <p>[Lighting technology (V)] The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources and luminaires. After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.</p> <p>[Lighting technology (Ü)]</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and construction of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> </ul>			
<b>Objective qualification</b>			

After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.

**Literature**

Lecture notes and slides

Hans-Jürgen Hentschel (Hrsg.): Licht und Beleuchtung; Hüthig 2002, ISBN 3-7785-2817-3

Horst Lange (Hrsg.): Handbuch für Beleuchtung; Landsberg 2007, ISBN 978-3-609-75390-4



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzsript Hans-Jürgen Hentschel: Licht und Beleuchtung Horst Lange: Handbuch für Beleuchtung			
	1,0	Exercise	german

<b>Title</b>	Lighting Engineering		
<b>Number</b>	2413590	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-59	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	5 / 7,0	<b>Module owner</b>	Prof. Dr. Andreas Waag
<b>Workload (h)</b>	210		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	140
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	oral exam (30 min) or written exam (90 min)		
<b>Course achievement</b>	Lab work		
<b>Contents</b>			
<p>The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources, luminaires and the relevant DIN standards. Special focus: Lighting technology and lighting technology for the automotive sector</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and design of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> <li>• Applications (lighting technology, Automotive Lighting)</li> </ul> <p>[Lighting technology (V)] The module provides an overview of lighting technology, from the physical principles of light and lighting to the manufacture of light sources and luminaires. After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.</p> <p>[Lighting technology (Ü)]</p> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• The nature of light: physical principles</li> <li>• The human perception of light</li> <li>• Production and construction of light sources</li> <li>• Module structure</li> <li>• Energy balances</li> <li>• Standardisation</li> </ul>			
<b>Objective qualification</b>			

After completing the module, students will be able to characterise light sources and illuminants, optimise their efficiency and solve simple lighting technology problems with the help of their parameters.

**Literature**

Lecture notes and slides

Hans-Jürgen Hentschel (Hrsg.): Licht und Beleuchtung; Hüthig 2002, ISBN 3-7785-2817-3

Horst Lange (Hrsg.): Handbuch für Beleuchtung; Landsberg 2007, ISBN 978-3-609-75390-4



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
Vorlesungsfolien und Kurzsript Hans-Jürgen Hentschel: Licht und Beleuchtung Horst Lange: Handbuch für Beleuchtung			
	1,0	Exercise	german
Laboratory practical course indoor lighting	2,0	Laboratory	german
<b>Literature</b>			
DIN 5035-5			

<b>Title</b>	Molecular Electronics		
<b>Number</b>	2413600	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-60	<b>Language</b>	english
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tobias Voß
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min)		
<b>Course achievement</b>	Presentation		
<b>Contents</b>			
<p>Introduction to molecular electronics                      basic considerations (molecular orbitals, conjugated systems)                      characterisation tools                      transport mechanisms                      conductive polymers                      optoelectronic applications of molecular systems</p>			
<b>Objective qualification</b>			
<p>Students are familiar with the fundamentals of organic chemistry. They can explain the structure of molecular orbitals and describe the different hybridization states of carbon atoms in the context of LCAO. They analyze the electron transfer between different molecules in the framework of the Marcus theory and can describe the essential aspects of electronic tunneling processes. They understand the content of current research publications and present them in short presentations. They can describe the structure of conductive polymers, their doping and electronic transport. They analyze the optoelectronic properties of polymers and organic dyes and can classify and explain the relevant electronic excitations and processes.</p>			
<b>Literature</b>			
<p>Introduction to Nanoscience, S.M. Lindsay, Oxford                      Polymer Electronics, M. Geoghegan, G. Hadziioannou, Oxford</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Molecular Electronics	2,0	Lecture	english
<b>Literature</b>			
"Molecular Nanoelectronics", M. A. Reed, T. Lee (Eds.), American Scientific Publishers (2003) "Introducing Molecular Electronics", Cuniberti et al. (Eds.), Springer (2005)			
	1,0	Exercise	english
<b>Literature</b>			
lecture slides, exercise materials			

<b>Title</b>	Optical Communications with Lab		
<b>Number</b>	2415220	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-22	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 6,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	180		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	124
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 minutes) or oral exam (30 minutes)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Optical fibers</li> <li>- Dispersion, velocities of light</li> <li>- Coherent modulation</li> <li>- Coherent receiver</li> <li>- Laser</li> <li>- Optical amplifier</li> <li>- Optoelectronic modulators</li> <li>- Photodetectors</li> <li>- Systems of optical communications</li> </ul>			
<b>Objective qualification</b>			
After completing the module, the students understand the mode of operation and know the performance characteristics of different components of optical transmission links. They can design and dimension fibre-optic transmission links.			
<b>Literature</b>			
S. L. Chuang, Physics of Photonic Devices, Wiley & Sons, ISBN 9780470293195			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

	2,0	Lecture	german
<b>Literature</b>			
- Skript zur Vorlesung - S. L. Chuang, Physics of Optoelectronic Devices, John Wiley & Sons			
	1,0	Exercise	german
	1,0	Laboratory	english
<b>Literature</b>			
Skript zum Praktikum			

<b>Title</b>	Dielectric Materials for Electronics and Photonics		
<b>Number</b>	2415250	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-25	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Wolfgang Kowalsky
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (120 min) or oral exam (30 min) or presentation		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>- Crystalline solids</li> <li>- Reciprocal lattice</li> <li>- X-ray deflection</li> <li>- Phonons</li> <li>- Dielectric properties of insulators (local electric field, mechanisms of polarization, Kramers-Kronig relations)</li> <li>- Thermal properties of insulators (Specific heat, thermal expansion, thermal conductivity)</li> <li>- Magnetic properties of diamagnetism and paramagnetism</li> <li>- Ferro-, antiferro-, and ferrimagnetism</li> </ul>			
<b>Objective qualification</b>			
After completion of the module students have deeper understanding of solid state physics of dielectrics, semiconductors, and metals. They developed the capability to design electronic and optoelectronic devices.			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Skript zur Vorlesung - N. W. Ashcroft, N. D. Mermin, Solid State Physics, Thompson Press, ISBN 8131500527</li> <li>- C. Kittel, Einführung in die Festkörperphysik, Oldenbourg, ISBN 3486577239</li> </ul>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
<b>Literature</b>			
- Skript zur Vorlesung - N. W. Ashcroft, N. D. Mermin, Solid State Physics, Harcourt School - C. Kittel, Einführung in die Festkörperphysik, Oldenbourg			
	1,0	Exercise	german

<b>Title</b>	Linear photonics with practical course		
<b>Number</b>	2415500	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-50	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min) or oral exam (30 min)		
<b>Course achievement</b>	Lab work		
<b>Contents</b>			
Ray optics, wave optics, Fourier optics, electromagnetic optics, quantum optics with practical experiments on: lenses, imaging, refraction, diffraction, interferometers, determination of optical constants, polarisation, Fourier optics, holography, laser, waveguide optics, quantum optics.			
<b>Objective qualification</b>			
After completing the module, the students know the essential fundamentals of modern photonics and can apply this knowledge to the assessment, design and simulation of photonic systems. Through the practical experiments offered, the students gain additional practical experience.			
<b>Literature</b>			
B.E.A. Saleh, M.C. Teich, Fundamentals of Photonics, (Wiley Series in Pure and Applied Optics)			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

	2,0	Internship	german
<b>Literature</b>			
B.E.A. Saleh, M.C. Teich, Fundamentals of Photonics, (Wiley Series in Pure and Applied Optics)			

<b>Title</b>	Linear Photonics		
<b>Number</b>	2415510	<b>Module version</b>	
<b>Shorttext</b>	ET-IHF-51	<b>Language</b>	german
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Hochfrequenztechnik
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	Prof. Dr. Thomas Schneider
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	56	<b>Self studying (h)</b>	94
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (90 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
Ray optics, wave optics, Fourier optics, electromagnetic optics, quantum optics with practical experiments on: lenses, imaging, refraction, diffraction, interferometers, determination of optical constants, polarisation, Fourier optics, holography, laser, waveguide optics, quantum optics.			
<b>Objective qualification</b>			
After completing the module, the students know the essential basics of modern photonics and are thus able to assess photonic and optical systems and technologies.			
<b>Literature</b>			
B. E. A. Saleh, M. C. Teich #Fundamentals of Photonics# John Wiley & Sons			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
	2,0	Lecture	german
	2,0	Exercise	german

<b>Title</b>	Electromagnetic Compatibility		
<b>Number</b>	2419120	<b>Module version</b>	
<b>Shorttext</b>	ET-IEMV-12	<b>Language</b>	german
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektromagnetische Verträglichkeit
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Dr. Harald Spieker
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Written exam (60 min) or oral exam (30 min)		
<b>Course achievement</b>			
<b>Contents</b>			
<ul style="list-style-type: none"> <li>• Terms and definitions of EMC</li> <li>• Sources of interference and disturbance variables, immunity of susceptible devices #</li> <li>• Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference #</li> <li>• Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection #</li> <li>• Legal basis, product liability, standardization #</li> <li>• EMC test engineering #</li> <li>• Electromagnetic compatibility of biological systems</li> </ul>			
<b>Objective qualification</b>			
<p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able to assess the EMC product safety by failure mechanisms.</p>			
<b>Literature</b>			
<ul style="list-style-type: none"> <li>- Lecture notes</li> <li>- Joachim Franz, EMV – Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X</li> <li>- Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1</li> <li>- Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9</li> </ul>			



<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
Either this module or "Electromagnetic Compatibility with Seminar" can be selected.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Electromagnetic Compatibility	2,0	Lecture	german
Electromagnetic Compatibility	1,0	Exercise	german

<b>Title</b>	Lab Course for Circuit Design		
<b>Number</b>	2420130	<b>Module version</b>	
<b>Shorttext</b>	ET-BST-13	<b>Language</b>	german
<b>Frequency of offer</b>	irregular	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für CMOS Design
<b>Hours per Week / ECTS</b>	4 / 5,0	<b>Module owner</b>	
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	70	<b>Self studying (h)</b>	80
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	Colloquium/lab journal as proof of achievement		
<b>Contents</b>			
<p>Lab Circuit Design:                      In the exercise, the necessary theoretical knowledge of the homodyne receiver to be set up in the laboratory is acquired.                      In the laboratory, a homodyne receiver (direct conversion receiver) for the 20m shortwave amateur radio band is completely constructed from discrete components. This receiver architecture, which does not require an intermediate frequency, is used in many modern mobile radio receivers (GSM, UMTS, WLAN, BLUETOOTH). The receiver consists of the following stages: Input amplifier, mixer, oscillator, baseband filter, AF preamplifier, and AF power amplifier. All stages are modeled one after the other using various modern circuit simulators, built discretely on a circuit board and carefully measured. The functionality of the overall circuit is demonstrated in detail in the final experiment.</p> <p>Lab PSpice:                      In the exercise, the application of the simulator with its various types of analysis is presented. Basic circuits (source, gate and drain circuits), CMOS circuits such as cascode, differential amplifier, current mirror and simple operational amplifier circuits are dealt with in the laboratory.                      In recent decades, PSPICE has developed into an industrial standard tool for circuit simulation, which is used in the design of analog circuits.                      The transistor models required for simulation, which are kindly provided by the IHP Leibnitz Institute in Fankfurt/Oder, correspond to a real 0.25um technology from Motorola.</p>			
<b>Objective qualification</b>			
<p>Lab Circuit Design:                      The students know how to set up, simulate and test a shortwave homodyne receiver.</p> <p>Lab PSpice:                      Students can carry out circuit simulations with transistor models commonly used in industry on the basis of PSpice, closely following the content of the lecture "Circuit design". The simulation results in a better insight of the circuits and enables the investigation of important effects of real circuits that can no longer be determined by analytical manual calculation.</p>			
<b>Literature</b>			

R. Heinemann: PSpice-Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3

**Remark**

Usually, the Lab Circuit Design takes place in the winter semester, the Lab PSpice in the summer semester.



**Related courses**

**Rules for the choice of courses**

Alternatively:

- Circuit design (Lab + exercise)
- PSpice (Lab + exercise)

The PSpice practical course can be taken parallel to the lecture on circuit design.

Recommendation: Knowledge of the modules "Circuit Theory" and "Circuit Design".

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

	4,0	Internship	german
--	-----	------------	--------

	2,0	Exercise	german
--	-----	----------	--------

**Literature**

R. Heinemann: PSPICE - Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3

	2,0	Internship	german
--	-----	------------	--------

**Literature**

R. Heinemann: PSPICE - Einführung in die Elektroniksimulation, Carl Hanser Verlag München 2001/2003, ISBN 3-446-21656-3

	1,0	Exercise	german
--	-----	----------	--------

<b>Title</b>	Molecular Electronics		
<b>Number</b>	2413600	<b>Module version</b>	
<b>Shorttext</b>	ET-IHT-60	<b>Language</b>	english
<b>Frequency of offer</b>	only in the summer term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Halbleitertechnik
<b>Hours per Week / ECTS</b>	3 / 5,0	<b>Module owner</b>	Prof. Dr. Tobias Voß
<b>Workload (h)</b>	150		
<b>Class attendance (h)</b>	42	<b>Self studying (h)</b>	108
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min)		
<b>Course achievement</b>	Presentation		
<b>Contents</b>			
<p>Introduction to molecular electronics                      basic considerations (molecular orbitals, conjugated systems)                      characterisation tools                      transport mechanisms                      conductive polymers                      optoelectronic applications of molecular systems</p>			
<b>Objective qualification</b>			
<p>Students are familiar with the fundamentals of organic chemistry. They can explain the structure of molecular orbitals and describe the different hybridization states of carbon atoms in the context of LCAO. They analyze the electron transfer between different molecules in the framework of the Marcus theory and can describe the essential aspects of electronic tunneling processes. They understand the content of current research publications and present them in short presentations. They can describe the structure of conductive polymers, their doping and electronic transport. They analyze the optoelectronic properties of polymers and organic dyes and can classify and explain the relevant electronic excitations and processes.</p>			
<b>Literature</b>			
<p>Introduction to Nanoscience, S.M. Lindsay, Oxford                      Polymer Electronics, M. Geoghegan, G. Hadziioannou, Oxford</p>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>
Molecular Electronics	2,0	Lecture	english
<b>Literature</b>			
"Molecular Nanoelectronics", M. A. Reed, T. Lee (Eds.), American Scientific Publishers (2003) "Introducing Molecular Electronics", Cuniberti et al. (Eds.), Springer (2005)			
	1,0	Exercise	english
<b>Literature</b>			
lecture slides, exercise materials			

Title		Measurement Electronics with Experiments	
<b>Number</b>	2411330	<b>Module version</b>	
<b>Shorttext</b>	ET-EMG-33	<b>Language</b>	english
<b>Frequency of offer</b>	only in the winter term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik
<b>Hours per Week / ECTS</b>	6 / 8,0	<b>Module owner</b>	Prof. Dr. Meinhard Schilling
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	84	<b>Self studying (h)</b>	156
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Oral exam (30 min), written exam (120 min) only for a high number of participants		
<b>Course achievement</b>	Successful participation in lab work		
<b>Contents</b>			
<p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> <li>- Electronic switches</li> <li>- Source circuits</li> <li>- Measuring transducers</li> <li>- Analogue filter circuits</li> <li>- Treatment of interference signals and noise</li> <li>- Correlation analysis</li> <li>- Measurement converters (A/D and D/A)</li> <li>- Measuring device buses</li> <li>- Time measurement</li> <li>- Oscilloscopes and trigger circuits</li> </ul> <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> <li>- Electronically controllable switches</li> <li>- Reference sources for voltages and currents</li> <li>- Measuring amplifiers</li> <li>- Analogue-to-digital/digital-to-analogue converters</li> <li>- Time and frequency measurement</li> <li>- Oscilloscope</li> <li>- Correlator</li> </ul>			
<b>Objective qualification</b>			
<p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p>			

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

**Literature**

A multi-media CD ROM with script and exercises is available for the lecture  
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827  
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926  
 - Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263  
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175  
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



**Related courses**

**Rules for the choice of courses**

**Compulsory attendance**

Name of the course	SWS	Eventtype	Language
--------------------	-----	-----------	----------

Measurement Electronics	2,0	Lecture	german
-------------------------	-----	---------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Measurement Electronics	1,0	Exercise	german
-------------------------	-----	----------	--------

**Literature**

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

Electronics measurement internship	3,0	Internship	german
------------------------------------	-----	------------	--------

**Literature**

Internship script

**Interdisciplinary Qualification**

Title	Professionalisation		
<b>Number</b>	2499550	<b>Module version</b>	
<b>Shorttext</b>	ET-STDE-55	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	2	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 6,0	<b>Module owner</b>	
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>		<b>Self studying (h)</b>	
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	Coursework: according to the requirements of the course taken from the pool; Seminar lecture: presentation according to § 4 para. 14		
<b>Contents</b>			
individual			
<b>Objective qualification</b>			
Key skills are acquired in the areas listed below:  - Action-orientated courses, scientific cultures Courses from the overall programme (pool) of interdisciplinary courses at the Technische Universität Braunschweig must be selected for this purpose. The type of examination or coursework and the number of credit points will be announced individually for each module.  <a href="https://www.tu-braunschweig.de/studium-lehre/im-studium/lehrveranstaltungen">https://www.tu-braunschweig.de/studium-lehre/im-studium/lehrveranstaltungen</a> The Dean of Studies ensures that a list of available courses is published each semester, in which recommendations are made for courses with particular practical relevance.  - Seminar lecture Seminar presentation at one of the institutes of the EITP faculty involved in the degree programme. An independent examination of a topic, including and analysing relevant literature, as well as the presentation and communication of the results in an oral presentation and subsequent discussion.			
<b>Literature</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
A total of 6-8 credits must be earned. The seminar presentation can be included as part of the professionalisation with 2 credits.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

<b>Title</b>	Industrial Internship		
<b>Number</b>	2499600	<b>Module version</b>	
<b>Shorttext</b>	ET-STDE-60	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	6 / 6,0	<b>Module owner</b>	
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>		<b>Self studying (h)</b>	
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	Written activity report in accordance with the separate regulations "Internship Guidelines of the FK Electrical Engineering, Information Technology, Physics"; Presentation according to § 4 para. 14		
<b>Contents</b>			
Individual; requirements according to internship guidelines			
<b>Objective qualification</b>			
On completion of the module, students will have gained an insight into organisational and operational processes and structures as well as working methods of engineering activities in industrial companies. After completing the module, students will have gained initial concrete experience and the related confidence to act in a professional environment. They will have appropriate patterns and options for action that are appropriate to the situation. These have been developed by dealing with issues such as conducting conversations, presentation techniques, time and self-management, intercultural training and, in particular, through practical experience. Students have become familiar with operational and/or project-related/industry-related processes, in particular working in teams, project work and project organisation.			
<b>Literature</b>			
<b>Remark</b>			
The activities carried out as part of the industrial internship must be presented in an ungraded presentation. This presentation, including preparation and follow-up work, counts for 2 credits within the 8 credits of this module. The workload is exclusively at the location of the industrial partner, usually outside the university.			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
An industrial internship of 6-8 weeks (6-8 CP) can be accredited.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

<b>Title</b>	Team Project		
<b>Number</b>	2499610	<b>Module version</b>	
<b>Shorttext</b>	ET-STDE-61	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 8,0	<b>Module owner</b>	
<b>Workload (h)</b>	240		
<b>Class attendance (h)</b>	160	<b>Self studying (h)</b>	80
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>			
<b>Course achievement</b>	Draft (§ 9 para. 6 APO) with written project planning and report; Presentation (§ 4 para. 14 BPO)		
<b>Contents</b>			
individual			
<b>Objective qualification</b>			
The team project is generally completed in groups of at least 3 students who carry out the design, analysis, construction or simulation of an electrical or information technology system using an overarching topic as an example.			
<b>Literature</b>			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
The team project can replace the industrial internship.			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

<b>Title</b>	Bachelor's Thesis		
<b>Number</b>	2499590	<b>Module version</b>	
<b>Shorttext</b>	ET-STDE-59	<b>Language</b>	german
<b>Frequency of offer</b>	every term	<b>Teaching unit</b>	Fakultät für Elektrotechnik, Informationstechnik, Physik
<b>Module duration</b>	1	<b>Institution</b>	
<b>Hours per Week / ECTS</b>	0 / 15,0	<b>Module owner</b>	Studiendekan Elektrotechnik
<b>Workload (h)</b>	900		
<b>Class attendance (h)</b>		<b>Self studying (h)</b>	
<b>Compulsory requirements</b>			
<b>Expected performance/ Type of examination</b>	Preparation of the Bachelor's thesis; Presentation (according to § 4 para. 14 BPO)		
<b>Course achievement</b>			
<b>Contents</b>			
individual			
<b>Objective qualification</b>			
<p>With the successful completion of the final thesis (§ 14 APO) and the presentation, the student demonstrates that he/she is able to work independently on a problem from the chosen subject area using scientific methods within a specified period of time. The qualification objectives of the degree program (Annex 1, § 2 APO) are reflected in the implementation and results of the final thesis with regard to the following components:</p> <ul style="list-style-type: none"> <li>• Independent familiarisation with and scientific methodical processing of a topic fundamentally relevant to further development and research in the field of electrical engineering</li> <li>• Literature research and presentation of the state of the art</li> <li>• Development of new solution approaches for a scientific problem</li> <li>• Presentation of the approach and results in the form of a paper</li> <li>• Presentation of the main results in a comprehensible form</li> <li>• Consolidation and refinement of key qualifications: management of an own project, presentation techniques and rhetorical skills</li> </ul>			
<b>Literature</b>			
<b>Remark</b>			
The Bachelor's thesis is credited with 12 credits and the presentation with 3 credits.			

↑

<b>Related courses</b>			
<b>Rules for the choice of courses</b>			
<b>Compulsory attendance</b>			
<b>Name of the course</b>	<b>SWS</b>	<b>Eventtype</b>	<b>Language</b>

