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Institute of Electrical Engineering and Information Theory

**Faculty**
Faculty of Engineering

**Examination Office**
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**Module Coordinator**
Prof. Dr.-Ing. Gerhard Schmidt

**Organizer**
Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
-

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Prerequisites for the examination as stated in the Examination Regulations: Presentation

Course Content

Digital processing of continuous-time signals
- Sampling and sampling theorem
- Quantization
- AD- and DA-conversion

Efficient FIR structures
- Block-based approaches

DFT and FFT
- Leakage effect
- Windowing
- FFT structure

Digital filters
- FIR filters
- Structures
- Linear phase filters
- Least-squares frequency domain design
- IIR-filters
- Structures
- Finite word-length effects

Multirate digital signal processing
- Decimation and interpolation
- Filters in sampling rate alteration systems
- Polyphase decomposition and efficient structures
- Digital filter banks

Learning Outcome

Students have an in-depth understanding of the differences of analog and digital processing. They apply robust and efficient versions of digital signal processing structures. They compare different filter approaches. Students deepen their knowledge on sampling and complexity reduction.

Reading List

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<td>Prof. Dr.-Ing. Marco Liserre</td>
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Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations

- 

Recommended Requirements

- 

Module Courses

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

The course is a basic course for developing a career in power electronics. The current drivers in power electronics design are efficiency, reliability and cost. Reliability has become only recently one of the main topics in power electronics and it is expected to be a major player in future years, due to the growing use of power electronics and the consequent safety concerns. Furthermore reliability affects deeply the cost of the system because of the cost of maintenance. Both reliability and efficiency depend on the management of the temperature, hence thermal models are very important. The topologies of PWM converters and the modulation have a deep impact on efficiency and reliability as well as on the power quality.

**Topics overview:**
- Design of a Power Electronics Converter (Semiconductors and Drivers, Soft and hard switching, Busbar design, EMC problems and remedies, Thermal model)
- Topologies of PWM power converters (dc/dc, dc/ac, ac/ac): single-cell and multi-cell converters, matrix converters etc.
- PWM modulation (single-phase, three-phase, space-vector, multilevel, interleaving, continuous/discontinuous, optimized)

### Learning Outcome

The students have an in-depth knowledge in the design process of power electronics converters characterized by high efficiency and high reliability. The students have developed a working understanding about how to handle the electrical energy conversions in applications ranging from power supplies to renewable energies and electric drives. The students focus on power converters based on Pulse Width Modulation, and are able to design the power converter starting from the components (mainly semiconductors, passive elements and cooling system) toward the choice of the proper topology and consequently the selection of the modulation strategy.

### Reading List

<table>
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<td>Digital Communications II</td>
<td>etit5003-01a</td>
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**Module Coordinator**

Prof. Dr.-Ing. Stephan Pachnicke

**Organizer**

Institute of Electrical Engineering and Information Theory – Communications

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits** 5

**Evaluation** Graded

**Duration** One Semester

**Frequency** Only takes place during winter semesters

**Workload per ECTS Credit** 30 hours

**Total Workload** 150 hours

**Contact Time** 60 hours

**Independent Study** 90 hours

**Teaching Language** English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- 

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

**Equalization of digital transmission systems**: Fundamentals of FIR-equalizers, blind equalization, nonlinear equalization, optimum receivers, maximum likelihood sequence estimation, Viterbi detector.

**Code-division multiple access (CDMA)**: Working principle, pseudo-noise sequence, code synchronization.

**Multicarrier transmission (OFDM, DMT)**: Working principle, digital implementation using DFT, guard interval, equalization, symbol mapping, bit- and power loading, PAPR reduction, spectral properties, system examples.

**MIMO-Systems**: Development & benefits, system model, eigenmodes, MIMO channel capacity and „waterfilling“ principle, successive interference cancellation, diversity, maximum ratio combining, application examples for future MIMO-systems with multi-mode or multi-core fibers.

**Introduction into channel coding**: Working principle, block codes, convolutional codes, signal space coding, channel capacity and Shannon-limit.

**Application examples**: Digital Audio Broadcasting (DAB), Digital Video Broadcasting (DVB), Digital Subscriber Line (DSL), WIFI (Wireless LAN), Bluetooth, optical wireless transmission, inter-satellite communications, optical underwater communications, fiber-optical high-speed transmission

Learning Outcome

This module teaches advanced knowledge in digital communications. The students will be able to understand the basic working principles of exemplary transmission systems. They know the major equalization techniques and advanced modulation formats. Based on that they will be enabled to build and assess digital communication systems on their own.

Reading List

Module Name | Module Code
---|---
Digital Electronics | etit5004-01a

**Module Coordinator**
Prof. Dr. Hermann Kohlstedt

**Organizer**
Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Graded

**Duration**
One Semester

**Frequency**
Only takes place during winter semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
45 hours

**Independent Study**
105 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
- 

**Recommended Requirements**
- Basics in Electronics
- Materials Science Lecture

**Module Courses**

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

1. **Logic circuits**
   - Boolean algebra, logic and logic gates, combinational logic circuits, sequential logic circuits, circuit design (VLSI and ASICs)
2. **Limits of Binary Computation**
   - Binary states variables, physical limits of computation, Moore's law
3. **Random Access Memories**
   - DRAM, Flash memories (EPROM, EEPROM), FeRAM, FeFET, MTJ, MRAM
4. **Resistive Random Access Memories**
   - The memory gap problem, PCM, FTJ, ECM and VCM, TCM
5. **Mass Storage**
   - DVD, Hard Disk Drives

### Learning Outcome

Students acquire an overview on current RAM technologies: the physical background, typical applications and physical limits of different RAM and mass storage devices. They have a profound understanding of various RAM technologies and valuation of their advantages and disadvantages. They can describe current difficulties and developments in RAM-technologies and have an overview of recent research approaches. Students are able to design logic circuits and can explain their principle function. They understand the physical background of different RAM devices, their scaling limits and functional principles.

### Reading List

- CMOS Processors and Memories, K. Iniewski, Springer 2010
- Nanometer sized CMOS IC’s: From Baiscs to ASICs, H. Veendick, Springer 2008
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**Module Coordinator**

Prof. Dr.-Ing. Ludger Klinkenbusch

**Organizer**

Institute of Electrical Engineering and Information Theory – Computational Electromagnetics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

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**Workload per ECTS Credit** 30 hours

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**Teaching Language**

English

Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations

- 

Recommended Requirements

- 

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Basic equations:
- Maxwell’s equations, curl-free quasistationary fields, diffusion, Nernst-Planck equation
- Electric properties of the cell:
  - Diffusion und ionic currents in the cell membrane, ion channels, sodium-potassium-pump, Nernst potential, equivalent circuit, Hodgkin-Huxley model
- Nerve cells:
  - Structure and function, cable equation, propagation along an axon
- Electrical properties of the heart:
  - Basic anatomy, electrical system, electrocardiography (ECG), magnetocardiography (MCG), pacemaker
- Electrical properties of the brain:
  - Basic anatomy, Electroencephalography (EEG), magneto encephalography (MEG), deep-brain stimulation (DBS)
- The eye as an electromagnetic sensor:
  - Basic anatomy, light reception in the retina and corresponding network
- Biological effects of electromagnetic fields:
  - Effects of low-frequency electric and magnetic fields
  - Effects of high-frequency electromagnetic fields

Learning Outcome

The students are able to describe the electrophysiological processes in the human body and several electromagnetically based methods for diagnosis and therapy. They are able to judge the electromagnetic effects in and threats to living organism and have the ability to electrically model electrophysiological processes.

Reading List

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**Module Coordinator**
Prof. Dr. Hermann Kohlstedt

**Organizer**
Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Graded

**Duration**
One Semester

**Frequency**
Only takes place during winter semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
45 hours

**Independent Study**
105 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

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**Recommended Requirements**
- Basics in Electronics
- Materials Science Lecture

**Module Courses**

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Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Vacuum physics and vacuum technology, basics of film growth and preconditions
Deposition technology
- evaporation, dc and rf sputtering, metal organic vapor deposition (MOCVD), pulsed Laser deposition (PLD), molecular beam epitaxy, Langmuir-Blodgett technique, nanoimprint techniques, bottom-up techniques
Etching
- wet and dry etching, plasma etching, reactive ion etching, ion beam etching including mass spectrometry
Lithography
- optical and e-beam lithography, photo resist, resolution
CMOS technology
- scaling laws, strained silicon, silicon on insulator (SOI), finFET, beyond CMOS

Learning Outcome

Students can describe essential and fundamentals in thin film technology and electronics device fabrication techniques. They are able to dimension a vacuum system in dependency of the goal, classify different deposition, etching and lithography systems and decide which technology fits best to certain material class and electronics device. Students are able to classify process flows and estimation of their degree of complexity.

Reading List

- Scriptum of the lecture available on the Kiel University OLAT learning platform
- Fundamentals of Microfabrication, CRC Press, Marc Madou
Module Name | Module Code
-------------|-------------
Information Theory and Coding I | etit5007-01a

Module Coordinator
Prof. Dr.-Ing. Peter A. Höher

Organizer
Institute of Electrical Engineering and Information Theory – Information Theory and Coding

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
Evaluation | Graded
Duration | One Semester
Frequency | Only takes place during winter semesters
Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 45 hours
Independent Study | 105 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements
- 

Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<th>Compulsory/Optional</th>
<th>Weighting</th>
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</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Fundamentals:
Shannon’s source coding theorem, Shannon’s channel coding theorem, Shannon’s crypto system
Multiuser information theory:
Broadcast channel, multiple-access channel, relay channel, channel capacity for Gaussian multiuser channels
Joint source and channel coding:
Lossy source coding, Shannon’s rate-distortion theory
Network coding

Learning Outcome

The students acquire an in-depth knowledge on information theory. They are able to professionally use source coding methods (data compression), channel coding techniques (error correction and error detection), and cryptology (data security). They gain insight into multiuser communication and network coding. The students are able to assess the performance of modern information systems by means of theoretical bounds and/or computer simulation.

Reading List


Additional German Reading:
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tr>
<td>Information Theory and Coding II</td>
<td>etit5008-01a</td>
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**Module Coordinator**

Prof. Dr.-Ing. Peter A. Höher

**Organizer**

Institute of Electrical Engineering and Information Theory – Information Theory and Coding

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

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<td>Only takes place during summer semesters</td>
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</table>

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

45 hours

**Independent Study**

105 hours

**Teaching Language**

English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

-  

**Recommended Requirements**

- „Information Theory & Coding I“ (module etit-510) is NO prerequisite

**Module Courses**

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

**Fundamentals of channel coding:**
- Block codes and convolutional codes
- LDPC codes:
  - Tanner graph, belief propagation, optimization of LDPC codes
- Turbo codes:
  - LLR algebra, BCJR algorithm, EXIT chart analysis, code concatenation
- Coded modulation:
  - Trellis-coded modulation, multilevel coding, bit-interleaved coded modulation, superposition modulation
- Polar codes: Design principle and capacity bound

### Learning Outcome

The students acquire an in-depth knowledge about channel coding and corresponding decoding algorithms. They can protect data against transmission/storage errors in applications like wireless radio, optical communications, and CD/DVD/bluRay discs. The students are able to design and to evaluate powerful channel coding techniques, and they can design and evaluate advanced channel decoding algorithms.

### Reading List


**Additional German Reading:**
**Module Name**  
Introduction to Low-power CMOS System Design

**Module Code**  
etit5017-01a

**Module Coordinator**  
Prof. Robert Rieger, Ph.D.

**Organizer**  
Institute of Electrical and Information Engineering – Networked Electronic Systems

**Faculty**  
Faculty of Engineering

**Examination Office**  
Examination Office Electrical and Information Engineering

| ECTS Credits | 5 |
| Evaluation | Graded |
| Duration | One Semester |
| Frequency | Only takes place during summer semesters |
| Workload per ECTS Credit | 30 hours |
| Total Workload | 150 hours |
| Contact Time | 45 hours |
| Independent Study | 105 hours |
| Teaching Language | English |

**Further Information on the Teaching Language**  
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**  
-  
**Recommended Requirements**  
- Knowledge of MOSFET operating principles, familiarity with basic circuit analysis methods  
- Nachrichtenübertragung (Modul etit-114)  
- Signale und Systeme I und II (Module etit-104 und etit-108)

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

This course covers basic aspects of low-power system design with a focus on portable, battery-powered applications. Based on the understanding that power consumption must be optimized on all design levels (device, circuit, architecture), special attention is paid to the discussion of low-power CMOS circuit blocks (circuit and architecture level). Starting with the digital circuits, students will analyze the dynamic power consumption of the inverter as a first example and will be able to extend the results to more general combinatorial circuits. Students will gain an understanding of analog circuits for voltage conversion (LDO, principle of DC-DC conversion) and switched-capacitor amplifier circuits with respect to functionality and power consumption. They are able to analyze the operation of the circuits at the circuit level. Students will know about related challenges in low-power design (e.g. current mirrors for low voltage operation and circuit noise).

In the accompanying exercise unit, students simulate circuit examples on the computer and compare with the analytical results from the lecture. They gain the foundation to be able to estimate circuit performance using simplified models for hand calculation.

Learning Outcome

Students understand the essential concepts for power optimization of digital and analog circuits on all design levels (device, circuit, architecture). They are familiar with strategies for low-power circuit design and can apply them. The students become familiar with the operating principles of selected essential integrated circuits (Switched-capacitor amplifiers, digital gates, voltage converters, etc.) and are able to analyze the circuits and determine their key design parameters.

Reading List

- Lecture handouts, including course slides.
<table>
<thead>
<tr>
<th>Module Name</th>
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<tbody>
<tr>
<td>Mathematical Methods in Field Theory</td>
<td>etit5009-01a</td>
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**Module Coordinator**  
Prof. Dr.-Ing. Ludger Klinkenbusch

**Organizer**  
Institute of Electrical Engineering and Information Theory – Computational Electromagnetics

**Faculty**  
Faculty of Engineering

**Examination Office**  
Examination Office Electrical and Information Engineering

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<td>Teaching Language</td>
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**Further Information on the Teaching Language**  
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**  
- 

**Recommended Requirements**  
- 

**Module Courses**

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Examination(s)

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**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

**Course Content**

Mathematical foundations: Dirac $\delta$-Function, $\delta$-convergent series, ortho-normalized function systems, Sturm-Liouville-Theory (Solution of boundary value problems with ordinary 2nd order differential equations)

Green's functions: Definition, properties, representations, solution of boundary value problems by means of Green's functions, 1st and 2nd boundary value problems (Dirichlet and Neumann problems)

Helmholtz- and Laplace equation: Separation in plane-polar coordinates, separation in spherical coordinates, free-space solutions

Multipole analysis of electromagnetic fields: Maxwell's equations, spherical-multipole analysis, plane-wave expansion, Diffraction by a sphere (Mie theory)

**Learning Outcome**

The students are able to describe standard mathematical methods in field theory and to analytically calculate scalar und vector fields. They can judge general features of linear operator equations in field theory and neighboring disciplines, e.g. systems theory. Students have the ability to mathematically model corresponding problems in engineering.

**Reading List**

Module Name | Module Code
------------|-------------
Microwave Circuits and Systems: Passive Circuits | etit5010-01a

Module Coordinator
Prof. Dr.-Ing. Reinhard Knöchel

Organizer
Institute of Electrical Engineering and Information Theory - Microwave Engineering

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
Evaluation | Graded
Duration | One Semester
Frequency | Only takes place during summer semesters
Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 60 hours
Independent Study | 90 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements
Knowledge about microwave technology of a B.Sc., general knowledge about circuits

Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/ Optional</th>
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<td>Lecture</td>
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<th>Weighting</th>
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<tr>
<td>Oral Examination: Microwave Circuits and Systems: Passive Circuits</td>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Lumped microwave components: capacitors, inductors, transformers
- Transmission lines for micro- and millimeterwaves: Rectangular and circular waveguides, microstrip lines and other transmission lines, transmissions between transmission lines
- Design procedures for circuits consisting of lumped elements, directional couplers, broadband transformers, baluns. Techniques for the improvement of the bandwidth
- Circulators, directional lines
- Resonators, microwave filter design using transmission lines and lumped elements
- Phase shifters, attenuators, mixers

Learning Outcome

The students have an in-depth understanding about the structure and function of passive microwave components. They can apply the principles and procedures for the design of passive microwave components. They have the knowledge of the pros and cons of different components. The students can design components regarding given system requirements. They are able to improve microwave components and create new ones. The students have an understanding of complex radiofrequency systems and are able to describe these systems.

Reading List

- David M. Pozar: Microwave Engineering, Wiley & Sons
- J. Helszajn: Passive and Active Microwave Circuits, Wiley & Sons

Additional German Reading

- Zinke, Brunswig: Hochfrequenztechnik 2, Springer
<table>
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<th>Module Name</th>
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<tbody>
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<td>Modeling and Control of Power Electronics Converters</td>
<td>etlt5011-01a</td>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. Marco Liserre

**Organizer**
Institute of Electrical Engineering and Information Theory – Power Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
- 

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

The course is focused on dc/dc and dc/ac PWM converters, their model and their control. Particularly, since most of the adopted dc/ac converters in electric drives and renewable energies are voltage source converters, the current control is the first and most important control stage and it is responsible of high dynamical behavior and low harmonic content. Finally the course focuses on how to select current references to achieve the desired active and reactive powers even in unbalance situations, using the instantaneous power theory, nowadays an indispensable tool for smart grid technologies.

Topics overview:
- dc/dc converter model
- Average model, small-signal linearization, transfer functions
- Design of the controller for dc/dc converters
- dc/ac converter model: ac dynamics in different reference frames
- Continuous and discrete current control (PI, resonant controller, deadbeat)
- dc voltage control, active and reactive power controls

Learning Outcome

The students are able to derive the mathematical models of PWM dc/dc and dc/ac converters. The students are able to design their controllers using average model and small-signal linearization. The students know basic of digital control and learn how to apply to power converters. The students have understanding of power theories and their application to power quality conditioner.

Reading List

<table>
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<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tr>
<td>Neuromorphic Engineering</td>
<td>etit5012-01a</td>
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</table>

**Module Coordinator**

Prof. Dr. Hermann Kohlstedt

**Organizer**

Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits** 5

**Evaluation** Graded

**Duration** One Semester

**Frequency** Only takes place during winter semesters

**Workload per ECTS Credit** 30 hours

**Total Workload** 150 hours

**Contact Time** 45 hours

**Independent Study** 105 hours

**Teaching Language** English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- Basics in Electronics
- Materials Science Lecture

**Module Courses**

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<th>Course Name</th>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Fundamentals:
Basics of biological nerves system divided in: behaviorism, cognitive psychology and genetics, power consumption, comparison to digital computers, Hebb’s learning rule.

Information processing in nerve systems:
Neurons, synapses, axons, action potential, characteristics parameters for information processing, leaky integrated and fire (LIF) model, pulse propagation, learning and memory in biology nerve systems, Spike-time-dependent plasticity (STDP), long term potentiation, long term depression (LTP/LTD), short survey on neuroinformatics: Perceptron, Adaline and Madaline networks.

Neuromorphic electronics:
Overview on neuromorphic engineering: analogue VLSI, ASIC’s, historical aspects, state-of-the art Short repetition on MOSFETs, low-power electronics, sub-threshold regime, various electronic function by operational amplifiers, leaky and integrated and firing circuits, axon-hillock circuits, memristors and memristor based circuits, outlook.

Learning Outcome
Students acquire an overview about the technology and strategies in neuromorphic engineering motivated by the fundamental mechanisms in biology nerve systems. They are able to describe fundamental biophysical mechanism in nerve cells and the information processing in biological neuronal systems and are able to classify neural networks. They understand various analog circuits for neuromorphic applications and are so able to describe the memristor principle including the material science background. Students are able to read and understand current papers in the field of neuromorphic engineering and are able to discuss the pro and cons of neuromorphic engineering in comparison to machine learning and digital computing.

Reading List
- Scriptum of the lecture available on the Kiel University OLAT learning platform
<table>
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<td>Nonlinear Control Systems</td>
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**Module Coordinator**

Prof. Dr.-Ing. habil. Thomas Meurer

**Organizer**

Institute of Electrical Engineering and Information Theory – Automatic Control

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

<table>
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<td>Frequency</td>
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<td>Workload per ECTS Credit</td>
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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- 

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Introduction to the dynamic analysis of nonlinear systems
- Lyapunov theory and Lyapunov-based design methods
- Differential geometric basics and methods
- Exact input-output linearization and exact input-state linearization
- Differential flatness
- Computer-algebra-systems in control design

Learning Outcome

The students have an in-depth understanding of nonlinear control systems. They understand the underlying differential geometric concepts and are able to apply these to new problems. The students are able to analyze control theoretic properties. They have a comprehensive understanding of the nonlinear control design methods and are able to independently apply these methods to nonlinear control problems.

Reading List

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Communications</td>
<td>etit5014-01a</td>
</tr>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. Stephan Pachnicke

**Organizer**
Institute of Electrical Engineering and Information Theory – Communications

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**  5
**Evaluation**  Graded
**Duration**  One Semester
**Frequency**  Only takes place during summer semesters
**Workload per ECTS Credit**  30 hours
**Total Workload**  150 hours
**Contact Time**  60 hours
**Independent Study**  90 hours
**Teaching Language**  English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
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**Module Courses**

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Examination(s)

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. This module is suitable as technical optional module in the bachelor’s degree programmes „Electrical Engineering and Information Technology“ and „Electrical Engineering, Information Technology and Business Management“.

Course Content

**General Overview:** Optical communications systems and important applications in telecommunications

**Optical Transmission Channel:** Fiber loss and dispersion, optical signals in single mode fiber, types of single mode fibers for communication purposes, system model of the single mode fiber, polarization and polarization mode dispersion, nonlinearity of the transmission fiber and numerical modelling, impact on digital signal transmission, split-step Fourier method, propagation modes in fibers, characteristics of multimode fibers

**Optical Transmitters:** Characterization of semiconductor lasers, materials, energy-band diagram, guidance of laser beams, design of lasers, Fabry-Perrot resonator, lasing condition, single-mode lasers, rate equations, power-current characteristic, direct modulation of lasers, laser-chirp, small-signal analysis, laser-frequency response

**Optical Modulators:** External modulators, electro-absorption modulator (EAM), Mach-Zehnder modulators (MZM), MZM model and characteristics, IQ-modulator (nested MZM)

**Optical Receivers:** block diagram & model, photo diodes, noise performance, clock and data recovery

**Optical Amplifiers:** principle of operation, main characteristics, noise performance

**Optical Filters:** Applications, Fiber Bragg gratings as filters, delay line filters, transfer functions

**Optical Transmission Systems:** System design, modulation formats, examples of typical applications

Learning Outcome

Students are able to describe fundamentals of optical communications and of the required optical and electronic components. They can discuss in detail the limiting effects of the optical communication channel based on a system-oriented view. They are able to explain the components used in transmitters and receivers of modern optical communication systems and can describe the major design aspects of optical transmission systems.

Reading List

- I. P. Kaminow, T. Li, A. E. Willner, „Optical Fiber Telecommunications V B: Systems and Networks“, ISBN: 0-12-374172-1
Module Name | Module Code
--- | ---
Optimization and Optimal Control | etit5015-01a

Module Coordinator
Prof. Dr.-Ing. habil. Thomas Meurer

Organizer
Institute of Electrical Engineering and Information Theory – Automatic Control

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

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Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- Recommended Requirements
  - Nonlinear Control Systems (Module etit5013-01a)

Module Courses

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**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

**Course Content**

- Fundamentals of static and dynamic optimization problems
- Static optimization without and with constraints
- Dynamic optimization without and with constraints
- Introduction to numerical methods for optimization.

**Learning Outcome**

The students have an in-depth understanding of static and dynamics optimization with constraints. They understand the underlying mathematical concepts and are able to apply these to new problems. They have a comprehensive understanding of optimization methods and are able to independently apply these methods to static and dynamic optimization problems. The students know different numerical solution approaches, comprehend their working principles and are able to implement them for optimization problems.

**Reading List**

- T. Meurer: Optimization and Optimal Control, Lecture notes.
- D.G. Luenberger, Y. Ye: Linear and Nonlinear Programming, Springer.
### Module Name
Rigid Body Dynamics and Robotics

### Module Code
etit5018-01a

### Module Coordinator
Prof. Dr.-Ing. habil. Thomas Meurer

### Organizer
Institute of Electrical Engineering and Information Theory – Automatic Control

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Graded

### Duration
One Semester

### Frequency
Only takes place during winter semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
45 hours

### Independent Study
105 hours

### Teaching Language
English

### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations
- 

### Recommended Requirements
- 

### Module Courses

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Rigid body kinematics
- Rigid body dynamics
- Analytical mechanics
- Robot kinematics, inverse kinematics and dynamics

Learning Outcome

The students have an in-depth understanding of rigid body kinematics and dynamics. They understand the underlying mathematical concepts and are able to apply these to new problems. They have a comprehensive understanding of the principles of analytical mechanics. The students can apply this knowledge to mathematically describe and analyze the kinematic and the kinetics of multi-body and robot systems. They comprehend the basic principles for model-based control of robot systems and are able to apply these.

Reading List

### Module Name

| Module Code | Wireless Communications etit5016-01a |

### Module Coordinator

*Prof. Dr.-Ing. Peter A. Höher*

### Organizer

Institute of Electrical Engineering and Information Theory – Information Theory and Coding

### Faculty

Faculty of Engineering

### Examination Office

Examination Office Electrical and Information Engineering

### ECTS Credits

| Credit | 5 |

### Evaluation

Graded

### Duration

One Semester

### Frequency

Only takes place during summer semesters

### Workload per ECTS Credit

30 hours

### Total Workload

150 hours

### Contact Time

45 hours

### Independent Study

105 hours

### Teaching Language

English

### Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

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### Recommended Requirements

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### Module Courses

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. This module is suitable as technical optional module in the bachelor’s degree programmes „Electrical Engineering and Information Technology“ and „Electrical Engineering, Information Technology and Business Management“.

Course Content

- **Fundamentals:** Wireless radio standards, classification of wireless radio systems, cellularization, uplink and downlink, multi-user access, frequency bands, software-defined radio
- **Channel modelling:** AWGN, Rayleigh/Rice fading, WSSUS channel model, equivalent discrete-time channel model
- **Digital modulation schemes:** PAM, QAM, PSK, CPM, OFDM
- **Multiple access techniques:** FDMA, TDMA, CDMA, IDMA, OFDMA
- **Equalization and channel estimation:** MLSE, LS CE
- **MIMO systems:** Space-time codes, spatial diversity, spatial multiplexing, beamforming

Learning Outcome

The students acquire a basic knowledge about fundamentals in the field of digital radio. The students learn the basics of wireless baseband techniques. They are able to design fundamental baseband algorithms suitable for software-defined radio, and they are able to evaluate radio subsystems. They are familiar with different wireless radio standards and they understand their differences and commonalities.

Reading List


Additional German Reading:

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<th>Code</th>
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<tr>
<td>In-depth Modules</td>
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**Organizer**
Institute of Electrical Engineering and Information Theory

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering
Module Name | Module Code
--- | ---
Advanced Methods in Nonlinear Control | etit6021-01a

Module Coordinator
Prof. Dr.-Ing. habil. Thomas Meurer

Organizer
Institute of Electrical Engineering and Information Theory – Automatic Control

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
--- | ---
Evaluation | Graded
Duration | One Semester
Frequency | Every Summer Semester
Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 45 hours
Independent Study | 105 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements

Module Courses

<table>
<thead>
<tr>
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<th>Course Name</th>
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Examination(s)

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</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Lyapunov’s first and second method
- Passivity-based control
- Backstepping control
- Extremun-seeking control
- Sliding-mode control

Learning Outcome

The students are able to explain the first and second method of Lyapunov and apply them for the stability analysis of nonlinear systems. They are able to decide for an appropriate control design method on the basis of the structural properties of a given system. The students can design controllers for nonlinear systems using different approaches and perform closed-loop stability analysis. They are able to implement basic numerical solvers for performing simulations of nonlinear control systems and discuss the performance of the closed-loop system.

Reading List

- Freeman, R., Kokotovic, P.V., Robust Nonlinear Control Design, Birkhäuser.
- Sepulchre, R., Jankovic, M., Kokotovic, P.V., Constructive Nonlinear Control, Springer-Verlag.
- van der Schaft, A., L2-Gain and Passivity Techniques in Nonlinear Control.
Module Name: Advanced Photonic Communication Systems
Module Code: etit6001-01a

Module Coordinator: Prof. Dr.-Ing. Stephan Pachnicke

Organizer: Institute of Electrical Engineering and Information Theory - Communications

Faculty: Faculty of Engineering

Examination Office: Examination Office Electrical and Information Engineering

ECTS Credits: 5
Evaluation: Graded
Duration: One Semester
Frequency: The module is offered irregularly.

Workload per ECTS Credit: 30 hours
Total Workload: 150 hours
Contact Time: 45 hours
Independent Study: 105 hours
Teaching Language: English

Further Information on the Teaching Language:
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations:

- Recommended Requirements:
  - Optical Communications (Module etit5014-01a)

Module Courses:

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

High-speed optical Core and Submarine Systems
- transmission schemes and modulation formats
- detection schemes, digital signal processing for coherent detection
- optical network elements

Optical Wireless Communication Systems
- basics and advances in optical satellite communication
- free-space terrestrial optical communication systems
- visible light communication systems

Optical Access Systems
- state-of-the art FTTx systems
- next generation optical access systems (OFDM/DWDM/UDWDM-PON)
- optical front- and backhaul systems

Optical Systems for Datacentre Applications
- high-speed Ethernet
- multimode fibre short-reach networks
- high-speed inter-datacentre connects

Learning Outcome

The students have a deep understanding of the design of optical transmission systems regarding different applications. They know the transmission impairments and mitigation methods. The students have the ability to numerically model and solve corresponding practical problems. They have competence to judge the properties of commercially available photonic design automation (PDA) software.

Reading List

- References are mostly taken from IEEE Xplore Digital Library and will be provided during the course.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tr>
<td>Adaptive Filters</td>
<td>etit6003-01a</td>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. Gerhard Schmidt

**Organizer**
Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Graded

**Duration**
One Semester

**Frequency**
Only takes place during summer semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
60 hours

**Independent Study**
90 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
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**Module Courses**

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Examination Name | Type of Examination | Evaluation | Compulsory/ Optional | Weighting
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Oral Examination: Adaptive Filters | Oral Examination | Graded | Compulsory | -

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Prerequisites for the examination as stated in the Examination Regulations: Presentation

Course Content

Students attending this lecture should learn the basics of adaptive filters. To achieve this, necessary algorithms will be derived and applied to problems arising in speech and audio processing. The algorithms comprise Wiener filtering, linear prediction, and adaptive schemes such as the NLMS algorithm, affine projection, and the RLS algorithm. For applications from speech and audio processing we use noise and reverberation reduction, echo cancellation, and beamforming.

Topic overview:
- Introduction and application examples (part 1 of 2)
- Signal properties and cost functions
- Wiener filter and principle of orthogonality
- Linear prediction
- RLS algorithm
- LMS algorithm and its normalized version
- Affine projection algorithm
- Fast version of adaptive algorithms
- Control of adaptive filters
- Efficient processing structures
- Applications of linear prediction
- Outlook and application examples (part 2 of 2)

Learning Outcome

Students can understand gradient-based learning rules which differ in terms of convergence speed and numerical complexity. Students comparing different approaches in a variety of signal and system properties. They apply the learned approaches to real-world problems. Furthermore, they can do research on related topics and present the results in a single person fashion or as a group work.

Reading List

- E. Hänsler, G. Schmidt: Acoustic Echo and Noise Control, Wiley, 2004
Module Name: Applied Nonlinear Dynamics
Module Code: etit6004-01a

Module Coordinator:
Prof. Dr.-Ing. habil. Thomas Meurer

Organizer:
Institute of Electrical Engineering and Information Theory – Automatic Control

Faculty:
Faculty of Engineering

Examination Office:
Examination Office Electrical and Information Engineering

ECTS Credits: 5
Evaluation: Graded
Duration: One Semester
Frequency: Only takes place during summer semesters
Workload per ECTS Credit: 30 hours
Total Workload: 150 hours
Contact Time: 45 hours
Independent Study: 105 hours
Teaching Language: English

Further Information on the Teaching Language:
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations:

- Recommended Requirements:
  - Nonlinear Control Systems (Module etit5013-01a)

Module Courses:

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Linear and nonlinear dynamical systems
- Qualitative behavior of vector fields
- Local and non-local bifurcations
- Discrete-time nonlinear systems
- Introduction to deterministic chaos

Learning Outcome

The students are able to explain fundamental system properties using terminology from linear and nonlinear system analysis. They can analyze the stability properties and existence conditions for stationary and periodic solutions of dynamical systems using local and non-local approaches. The students know the differences between the basic types of bifurcations in one and two-dimensional continuous and discrete-time systems. They are able to implement basic numerical solvers for performing simulations of dynamical systems.

Reading List

- J. Hale, H. Kocak: Dynamics and Bifurcations, Springer.
- S. Lynch: Dynamical Systems with Applications using Mathematica, Birkhäuser.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tr>
<td>Computational Electromagnetics</td>
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**Module Coordinator**

Prof. Dr.-Ing. Ludger Klinkenbusch

**Organizer**

Institute of Electrical Engineering and Information Theory – Computational Electromagnetics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits**

5

**Evaluation**

Graded

**Duration**

One Semester

**Frequency**

Only takes place during winter semesters

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

45 hours

**Independent Study**

105 hours

**Teaching Language**

English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- 

**Module Courses**

<table>
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<th>Course Name</th>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Maxwell’s equations:
Time- and frequency domain, constitutive equations for different media: non-linear, inhomogeneous, anisotropic, dispersive

Finite Differences:
1D example, Finite-Difference Time-Domain (FDTD) method, discretization, Yee grid, leap-frog algorithm, stability, numerical dispersion, simulation of free-space scattering problems, perfectly matched layer (PML), sub-celling, treatment of dispersive media, development of an 2-D FDTD source code

Finite Elements:
1D example: linear form functions, Galerkin method, Ritz method; 2D and 3D problems: discretization, scalar und vector linear elements, typical problems and formulations

Iteratively solving a system of linear equations:
Splitting methods, Krylov subspace methods

Learning Outcome

The students are able to explain the most common local numerical methods for the computation of electromagnetic fields. They have the ability to numerically model and solve corresponding practical electromagnetic problems. They can judge the properties of commercially available CEM software and decide for the most suitable CEM software for a given problem.

Reading List

### Module Name
Control of PDE Systems

### Module Code
etit6006-01a

### Module Coordinator
Prof. Dr.-Ing. habil. Thomas Meurer

### Organizer
Institute of Electrical Engineering and Information Theory – Automatic Control

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

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### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

- **Recommended Requirements**
  - Nonlinear Control Systems (Module etit5013-01a)

### Module Courses

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Introduction to the distributed parameter systems: Mathematical modeling, classification, solution techniques for partial differential equations
- Analysis and control design in frequency domain: input-output stability, output feedback control
- Analysis and control design in time domain: controllability and observability, stability theory, state feedback control, backstepping
- Flatness-based methods for trajectory planning and tracking control

Learning Outcome

The students have an in-depth understanding of control design methods for distributed parameter systems governed by partial differential equations. They understand the underlying mathematical concepts and are able to apply these to new problems. The students are able to analyze control theoretic properties for distributed parameter systems. They have a comprehensive understanding of the control design methods and are able to independently apply these methods to control problems involving partial differential equations.

Reading List

- T. Meurer: Control of PDE Systems, Lecture notes.
- M. Krstic, A. Smyshlyaev: Boundary Control of PDEs: A Course on Backstepping Designs, SIAM, Philadelphia.
## Module Name
Control of Robot Systems

## Module Code
etit6023-01a

### Module Coordinator
Prof. Dr.-Ing. habil. Thomas Meurer

### Organizer
Institute of Electrical Engineering and Information Theory – Automatic Control

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Graded

### Duration
One Semester

### Frequency
Only takes place during summer semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
45 hours

### Independent Study
105 hours

### Teaching Language
English

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### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

- Recommended Requirements
  - Rigid Body Dynamics and Robotics (Module etit5018-01a)
  - Nonlinear Control Systems (Module etit5013-01a)

### Module Courses

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

Course Content

- Robot kinematics, inverse kinematics and dynamics
- Trajectory and motion planning
- Position and force control
- Energy-based control

Learning Outcome

The students have an in-depth understanding of robot kinematics and dynamics, model-based motion planning and model-based position and force control of multi-DOF robotic manipulators. They are able to apply these independently to solve nonlinear control problems involving multi-DOF robotic manipulators and mobile robots.

Reading List

- T. Meurer: Control of Robot Systems – Lecture notes.
**Module Name**  
Design and Analysis of Selected Fundamental CMOS Circuits  

**Module Code**  
etit6019-01a  

**Module Coordinator**  
Prof. Robert Rieger, Ph.D.  

**Organizer**  
Institute of Electrical and Information Engineering – Networked Electronic Systems  

**Faculty**  
Faculty of Engineering  

**Examination Office**  
Examination Office Electrical and Information Engineering  

**ECTS Credits**  
5  

**Evaluation**  
Graded  

**Duration**  
One Semester  

**Frequency**  
Only takes place during summer semesters  

**Workload per ECTS Credit**  
30 hours  

**Total Workload**  
150 hours  

**Contact Time**  
30 hours  

**Independent Study**  
120 hours  

**Teaching Language**  
English  

**Further Information on the Teaching Language**  
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.  

**Entry Requirements as Stated in the Examination Regulations**  
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**Recommended Requirements**  
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**Module Courses**  

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Students are introduced to the design and analysis of several elemental CMOS integrated circuits. The course begins with a discussion of differential amplifiers and related design aspects, including the differential pair with passive load and active load, common-mode feedback, push-pull amplifier, source-follower, folded cascode, and instrumentation amplifier. The students learn how to apply a simplified expression for the channel-length modulation effect for resistance estimation. Furthermore, they understand the circuit principles of inductorless oscillator circuits (Wien-Bridge Oscillator, Gm-C quadrature oscillator, ring oscillator, relaxation oscillator). Approaches to on-chip amplitude stabilization are discussed. Further structures of interest are circuits for NTAT, PTAT and bandgap reference generation. The students will be able to predict circuit performance using SPICE-based simulation software.

Learning Outcome

The students comprehend the design concepts for essential analog integrated circuits (amplifier, oscillator, etc.) and the available design choices. They are aware of typical design trade-offs and of the design parameter space. The students are able to simulate CMOS integrated circuits using a SPICE-based software and employ engineering simplifications for design planning. They also obtain the skills to design the key circuit parameters and predict circuit performance. Students are also able to present a short engineering topic to a scientific audience.

Reading List

- Lecture handouts, including lecture slides
Module Name | Module Code
---|---
Electric Drives | etit6007-01a

**Module Coordinator**
Prof. Dr.-Ing. Marco Liserre

**Organizer**
Institute of Electrical Engineering and Information Theory – Power Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
-

**Module Courses**

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

Electric drives are a key technology for reducing energy consumption of industrial processes, for modern wind energy power generation and for enabling green-transportation (electric and hybrid vehicles, electric trains, more electric ships and airplanes). Moreover electric drives are starting to be widespread making easier everyday life with automation and robotics. The course starts from a deep modeling phase of ac electrical machines, nowadays the most used. Then the field oriented control of the asynchronous and synchro- nous (Permanent Magnet) machines are treated in details due to their wide use and importance in modern electric drives. Exercises are carried out with CAE-tools (Matlab/Simulink).

**Topics overview:**
- Space vector representation of electrical machines
- Dynamic model of the synchronous machine
- Dynamic model of the asynchronous machine
- Overview of PWM modulation
- Overview of Current Control techniques
- Vector control of the permanent magnet synchronous machine: Current control loop and Speed control loop
- Vector control of the asynchronous machine: Flux observer

### Learning Outcome

The students have in-depth understanding on the control of electric drives. The students can formulate the dynamical model of the most adopted electrical machines in electric drives, and consequently choice the design of their controllers. The students have developed experience in the control design of electrical machines through simulation software, like Matlab, and have validated the control strategies in Simulink environment.

### Reading List

### Module Name
Fiber-optic Communication Networks

### Module Code
etit6008-01a

### Module Coordinator
Prof. Dr.-Ing. Stephan Pachnicke

### Organizer
Institute of Electrical Engineering and Information Theory – Communications

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Graded

### Duration
One Semester

### Frequency
Only takes place during summer semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
60 hours

### Independent Study
90 hours

### Teaching Language
English

### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations
- 

### Recommended Requirements
- 

### Module Courses

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

1. Fundamentals of optical communications
2. Protocols used in optical networks
3. Network architectures
4. Monitoring, failure localization & protection switching
5. Network simulation and optimization

Learning Outcome

The students can explain the fundamental building blocks used in fiber optical communication networks and describe the physical properties of light propagation in optical fibers, major network elements, the network architecture as well as protocols and network management. They are able to use central methods to analyse practical networking, system and operational aspects and are able to optimize them. Finally, they are able to explain modern principles such as software-defined networking and network function virtualization.

Reading List

Module Name | Module Code
--- | ---
Grid Converters for Renewable Energy Systems | etit6009-01a

**Module Coordinator**
Prof. Dr.-Ing. Marco Liserre

**Organizer**
Institute of Electrical Engineering and Information Theory – Power Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Graded

**Duration**
One Semester

**Frequency**
Only takes place during winter semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
50 hours

**Independent Study**
100 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
Admission to this the module requires the successful completion of the module "Leistungselektronik Grundlagen" (etit-111).

**Recommended Requirements**
-

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Grid-connected PWM converters are gaining increasing importance in view of a growing contribution of Distributed Power Generation Systems (DPGS) to the total power flow in the European electric grid. This is also owed to an increasing inflow from Renewable Energy Sources (RES).

After a review of the power electronics solutions used for Photovoltaic (PV) and Wind Turbine (WT) systems and an overview about modulation and current/voltage control techniques, the course focuses on the specific issues related to the connection of a PWM converter to the grid. Exercises are carried out with CAE-tools (Matlab/Simulink).

Topics overview:
- PV converter topologies
- WT converter topologies
- Overview of PWM modulation
- Overview of Current Control techniques
- Single-phase synchronization with the electrical grid
- Three-phase synchronization with the electrical grid
- Harmonic rejection
- Grid-filter design and resonance issues
- Parallel connection of power electronics converters

Learning Outcome

The students have in-depth knowledge in designing the power electronics interface for Renewable Energy Systems to the electric grid. The students can recognize the different topologies associated to PV and wind Energy Systems and understand their working mechanism. The students can recognize, analyze and solve issues for electric grid interactive applications of these energy systems, such as synchronization, low frequency harmonic rejection and design of grid filters for reducing PWM harmonics. The students have developed experience in the control design of grid converters through simulation software, like Matlab, and have validated the control strategies in Simulink environment.

Reading List
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<td>Interface and Surface Analysis Methods in Materials Science</td>
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**Module Coordinator**

Prof. Dr. Hermann Kohlstedt

**Organizer**

Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- Basics in Electronics
- Materials Science Lecture

**Module Courses**

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

**Fundamentals:**
- Basics of interface and surface physics

**Scanning probe methods:**
- Scanning tunneling microscopy and spectroscopy
- Scanning force microscopy techniques (AFM, EFM, MFM, PFM, KPFM)

**Spectroscopy methods:**
- X-ray diffraction
- Rutherford backscattering spectrometry
- Secondary ion mass spectroscopy
- X-ray photoelectron spectroscopy
- Reflection high-energy electron diffraction

### Learning Outcome

Students get a broad overview over the most effective analytical methods used in thin film technology and are therefore able to characterize surfaces and interfaces including their physical and chemical principles. They are able to employ the appropriate surface analysis techniques in order to get specific information required in the field of thin film technology and analyze and interpret measured data in the field of surface characterization like XRD scans, XPS spectra, AFM/PFM images, etc.

### Reading List

- Oberflächenphysik des Festkörpers, M. Henzler und W. Göpel, Teubner Studienbücher
- Surface Analysis: The principal techniques, Vickerman Gilmore, Wiley
- Surfaces and Interfaces, H. Lüth, Springer-Verlag
- Fundamentals of Surface and Thin Film Analysis, Feldmann et al., North-Holland
## Module Name

### Integrated Circuit Design for Medical Applications etit6018-01a

### Module Coordinator

Prof. Dr.-Ing. Andreas Bahr

### Organizer

Institute of Electrical and Information Engineering – Sensor System Electronics

### Faculty

Faculty of Engineering

### Examination Office

Examination Office Electrical and Information Engineering

### ECTS Credits

5

### Evaluation

Graded

### Duration

One Semester

### Frequency

Only takes place during summer semesters

### Workload per ECTS Credit

30 hours

### Total Workload

150 hours

### Contact Time

60 hours

### Independent Study

90 hours

### Teaching Language

English

### Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

- 

### Recommended Requirements

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### Module Courses

<table>
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<tr>
<th>Course Type</th>
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<tr>
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<td>Exercise</td>
<td>Integrated Circuit Design for Medical Applications</td>
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</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

This course introduces the concepts and procedures of analog integrated circuit design – with a special focus on medical electronic applications.

- Analog integrated circuits
- Biomedical signal generation and information transfer
- Design-flow (analog) and development procedures
- Circuit design techniques
- Simulation of analog integrated circuits, Spice
- Chip Engineering (floorplan, placement, routing, physical layout)
- Reliability issues during the design phase (Parasitic effects, Electro migration, Electrostatic Discharge)
- Amplifiers
- Amplifiers for biomedical applications
- Example of electronic implants

Learning Outcome

The students have an in-depth understanding of the design of analog integrated circuits as well as the design techniques and procedures. They know the major methods of design, simulation and layout of analog integrated circuits as well as the details and the use of a professional design frame work (Cadence). The students know how to simulate the electrical functionality if integrated circuits and how to consider further aspects like reliability aspects during the development phase. They can use this knowledge to create new analog integrated circuits and enhance existing ones. They can perform analysis of highly complex integrated analog circuits and apply strategies for the efficient technological realization of complex integrated circuits.

Reading List

<table>
<thead>
<tr>
<th>Module Name</th>
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<tr>
<td>Microwave Circuits and Systems: Active Circuits</td>
<td>ett6011-01a</td>
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**Module Coordinator**

Prof. Dr.-Ing. Reinhard Knöchel

**Organizer**

Institute of Electrical Engineering and Information Theory - Microwave Engineering

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits**

5

**Evaluation**

Graded

**Duration**

One Semester

**Frequency**

Only takes place during winter semesters

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

45 hours

**Independent Study**

105 hours

**Teaching Language**

English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

Knowledge about microwave technology of a B.Sc., general knowledge about circuits

**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Active high frequency components: bipolar transistors, HBT, FET, integrated circuits, power transistors, klystron, travelling wave tube
- Amplifier circuits, small signal amplifiers, noise and amplifiers, low noise amplifiers, increasing of the bandwidth, travelling wave amplifiers, foundations of power amplifiers
- Improvement of linearity and efficiency, Doherty amplifier, envelope tracking, linear amplification using nonlinear components (LINC), sequential amplifiers
- Oscillators: general structure, stabilization of frequency, phase lock loops, synchronization of oscillators
- Design of active microwave circuits using software tools

Learning Outcome

The students have an in-depth understanding about the structure and function of active microwave components and circuits. They can apply the principles and procedures for the design of active microwave components and circuits. The students can design components regarding given system requirements. They are able to improve microwave components and create new ones. The students are able to explain complex radiofrequency systems.

Reading List

- David M. Pozar: Microwave Engineering, Wiley & Sons
- J. Helszajn: Passive and Active Microwave Circuits, Wiley & Sons

Additional German Reading

- Zinke, Brunswig: Hochfrequenztechnik 2, Springer
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<td>Microwave Filters: Theory, Design, and Realization</td>
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**Module Coordinator**
Prof. Dr.-Ing. Michael Höft

**Organizer**
Institute of Electrical Engineering and Information Theory - Microwave Engineering

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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<td>Total Workload</td>
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<td>Teaching Language</td>
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**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
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**Module Courses**

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</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

- Introduction to microwave filters
- Basic network theory
- Design of lumped lowpass prototype networks
- Circuit transformation on lumped prototype networks
- Coupled resonator circuits
- TEM transmission line filters
- Introduction to waveguide filters
- Introduction to dielectric resonator filters
- Introduction to different filter technologies
- Computer aided design

Learning Outcome

The students have an in-depth understanding of filter synthesis techniques, various filter characteristics and realization approaches. They can calculate the parameters of lowpass prototype networks. They can perform transformations on the networks. They can design and analyse filters for different applications based on given specifications. The students are able to select appropriate filter technology with appropriate electrical characteristics for different scenarios.

Reading List

- Relevant articles related to the topics.
<table>
<thead>
<tr>
<th>Module Name</th>
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<td>Numerical Simulation of Analog and Digital Communication Systems</td>
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**Module Coordinator**
Prof. Dr.-Ing. Stephan Pachnicke

**Organizer**
Institute of Electrical Engineering and Information Theory - Communications

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
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**Module Courses**

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Examination(s)

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Introduction:
- Numerical Simulation as method of investigation
- Comparison with other methods of investigation (experiments, theoretical modeling)

Basics:
- Description of communication systems by means of block diagrams, implementation of block diagrams into code
- Appropriate programming languages for local applications and distributed systems
- Signal sources (generators for random numbers, PRBS, PRMS)
- Signal analysis (measurement of S/N for analog systems, evaluation of bit error probability for digital systems, estimation of power spectrum density)
- Implementation of linear systems

Applications:
- Simulation of analog systems (e.g. speech processing)
- Simulation of digital systems (e.g. optical high-speed transmission systems)
- Parallel algorithms for efficient simulation on multi-core computers
- Processing on distributed systems

Learning Outcome

The students have a clear understanding of the potential of numerical simulation as flexible and cost-efficient tool for investigation into arbitrary communication systems. They are able to transfer real systems into computer code. They have a good overview on how to implement different elements of communication systems, such as signal generators and filters, and they can select suitable algorithms depending on their simulation scenario. For their simulation applications, they know which approaches for evaluation are appropriate. Finally, they have basic knowledge in the field of programming techniques for efficient use of today’s computer hardware and of distributed systems.

Reading List
- J. Leibrich, Modeling and simulation of limiting impairments on next generation’s transparent optical WDM transmission systems with advanced modulation formats, Shaker, 2007
<table>
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<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tr>
<td>Noise in Communications and Measurement Systems</td>
<td>etit6013-01a</td>
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**Module Coordinator**

Prof. Dr.-Ing. Michael Höft

**Organizer**

Institute of Electrical Engineering and Information Theory - Microwave Engineering

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits**

5

**Evaluation**

Graded

**Duration**

One Semester

**Frequency**

Only takes place during summer semesters

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

45 hours

**Independent Study**

105 hours

**Teaching Language**

English

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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

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**Recommended Requirements**

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**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

This module is suitable as technical optional module in the bachelor’s degree programmes „Electrical Engineering and Information Technology“ and „Electrical Engineering, Information Technology and Business Management“.

Course Content

- Thermal noise
- Mathematical and system-oriented fundamentals
- Noise of linear one- and two-ports
- Measurement of noise parameters
- Noise of diodes / shot noise
- Parametric theory for noise calculations in mixer circuits

Learning Outcome

The students have an in-depth understanding of noise phenomena in linear and basic understanding of noise in nonlinear microwave circuits. They know sources of noise in microwave circuits. They can analyse noise performance of simple circuits and components by applying the mathematical and system-oriented fundamentals. They can explain how measurements of noise parameters are performed and can point out where sources of errors exist in related setups. The students are able to calculate noise performance in mixer circuits by application of parametric theory. The students can determine the influences of noise phenomena on the sensitivity of communication and measurement systems.

Reading List

- B.Schiek, I. Rolfes, H.-J. Siweris; Noise in High-Frequency Circuits and Oscillators, Willey, 2006

Additional German Reading:
<table>
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<tr>
<th>Module Name</th>
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<tr>
<td>Pattern Recognition</td>
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**Module Coordinator**

Prof. Dr.-Ing. Gerhard Schmidt

**Organizer**

Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits**

5

**Evaluation**

Graded

**Duration**

One Semester

**Frequency**

Only takes place during winter semesters

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

60 hours

**Independent Study**

90 hours

**Teaching Language**

English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

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**Recommended Requirements**

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**Module Courses**

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. Prerequisites for the examination as stated in the Examination Regulations: Presentation

Course Content

In this lecture the basics of pattern recognition are treated. Often schemes that are based on statistical optimization are utilized for these applications. The involved cost functions are matched to the specific applications.

Topic overview:

Preprocessing to reduce signal distortions
- Noise reduction
- Beamforming

Basics of pattern recognition
- Fundamentals of selected applications
- Feature extraction
- Gaussian mixture models (GMMs)
- Neural networks (NN)
- Hidden Markov models (HMMs)

Selected applications:
- Recognition of speech and speakers
- Extending the bandwidth of speech signals

Learning Outcome

Students can investigate different feature extraction and data compression techniques. They can understand the principles of machine learning schemes and compare the different concepts. Students apply the learned approaches to real-world problems. Furthermore, they can do research on related topics and present the results in a single person fashion or as a group work.

Reading List

Statistical signal theory:

Noise reduction, beamforming, adaptive filters:
- E. Hänsler, G. Schmidt: Acoustic Echo and Noise Control, Wiley, 2004

Speech signal processing:
Module Name | Module Code
---|---
Photonic Components | ett6015-01a

Module Coordinator
Prof. Dr. Martina Gerken

Organizer
Institute of Electrical Engineering and Information Theory - Integrated Systems and Photonics

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

| ECTS Credits | 5 |
| Evaluation | Graded |
| Duration | One Semester |
| Frequency | Only takes place during winter semesters |
| Workload per ECTS Credit | 30 hours |
| Total Workload | 150 hours |
| Contact Time | 45 hours |
| Independent Study | 105 hours |
| Teaching Language | English |

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements
- Solid state physics
- Semiconductor devices

Module Courses

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

This course teaches the fundamentals and the design of photonic components based on the study of scientific publications. The following devices will be discussed:

- Light emitting diodes (LEDs)
- Organic light emitting diodes (OLEDs)
- Semiconductor lasers
- Optical switches
- Photo detectors
- Solar cells

### Learning Outcome

The students can perform a literature search on a specific topic and summarize the content of scientific publications. They can explain the working principles of photonic components. They can analyze the performance of photonic devices and develop design choices for improvement. They can assess scientific publications critically.

### Reading List

#### Mandatory literature
- A compilation of current research papers is handed out during the course.

#### Supplementary literature
- Schubert, E. F.: Light-emitting diodes, Cambridge University Press
- Würfel, P.: Physics of solar cells: from basic principles to advanced concepts, Wiley-Vch
## Module Name
Renewable Energy Systems

## Module Code
etit6016-01a

## Module Coordinator
Prof. Dr.-Ing. Marco Liserre

## Organizer
Institute of Electrical Engineering and Information Theory – Power Electronics

## Faculty
Faculty of Engineering

## Examination Office
Examination Office Electrical and Information Engineering

## ECTS Credits
5

## Evaluation
Graded

## Duration
One Semester

## Frequency
Only takes place during summer semesters

## Workload per ECTS Credit
30 hours

## Total Workload
150 hours

## Contact Time
50 hours

## Independent Study
100 hours

## Teaching Language
English

### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations
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### Recommended Requirements
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### Module Courses

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Examination(s)

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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Due to the increasing energy demand, especially in emerging countries, and environmental concerns, the penetration of renewable energies and distributed electric power generation is changing the face of the power system. The course covers those aspects that do not imply a deep knowledge of power electronics converters but that are anyway crucial for their proper design.

Topics overview:
- Basic principles of Wind and Photovoltaic
- PV-system design and control procedure
- WT-system design and control procedure
- Islanding
- Microgrid
- HVDC
- Biomass & Bio CHP Plant & Geothermal plants
- Energy Storage Systems basics & modelling and economic analysis
- E-mobility and Smart grid: basics

Learning Outcome

The students have a general knowledge about how renewable energy systems (especially Wind and Photovoltaic) work, how they are structured and how they are organized in parks. The students understand the issues related to the interaction with the electric grid, and they are able to analyze national grid codes and international standards compliance, mostly regarding faults and islanding conditions regulations. The students can generally discuss on advanced topics related to ancillary services, use of storage, micro-grid operation, Combined Heat and Power plants, Bio-gas and special connection using High Voltage DC Transmission.

Reading List

## Module Name
Selected Topics in Wireless Communications and Power Grids

## Module Code
etit6002-01a

### Module Coordinator
Prof. Dr.-Ing. Peter A. Höher

### Organizer
Institute of Electrical Engineering and Information Theory – Information Theory and Coding

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Graded

### Duration
One Semester

### Frequency
Only takes place during winter semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
45 hours

### Independent Study
105 hours

### Teaching Language
English

#### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

#### Entry Requirements as Stated in the Examination Regulations
- 

#### Recommended Requirements
- Wireless Communications

#### Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/Optional</th>
<th>SWS</th>
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</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

In each semester, focus will be on a different, innovative communications topic. Examples include Next Generation Wireless Communications, Visible Light Communications, Molecular Communications, Wireless Power and Information Transfer, and Communication via Power Grids. The selected topic will be announced before the module starts.

The module is offered in the form of an inverted classroom lecture. Every week, a new paper (frequently a tutorial) will be distributed to the participants. The students are expected to read the paper prior to the lecture. In the first part of a lecture, the paper will usually be discussed in teams. Afterwards, the paper will be discussed at the black board. There will be no weekly exercises. Instead, each student is expected to give a presentation on a selected topic at the end of the semester.

Learning Outcome

The students will learn to understand advanced communication techniques and to design new systems. Since the module is an inverted classroom lecture, students learn to solve problems both independently as well as team-oriented. They can design and analyze advanced system components. They are able to evaluate the overall system performance. The students will train to search, to read, and to understand technical papers, to work in teams, and to give a presentation at the end of the semester. They can critically assess latest developments.

Reading List

- Papers (mostly tutorials) will be distributed
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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</thead>
<tbody>
<tr>
<td>Tomographical Methods for Medicine</td>
<td>etit6017-01a</td>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. Ludger Klinkenbusch

**Organizer**
Institute of Electrical Engineering and Information Theory – Computational Electromagnetics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Graded

**Duration**
One Semester

**Frequency**
Only takes place during winter semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
45 hours

**Independent Study**
105 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
-

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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</tbody>
</table>

**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

**Introduction:**
Overview of medical imaging and tomographical methods

**Electrical-Impedance Tomography (EIT):**
- Principle of EIT
- Governing equations
- Solution of the inverse problem

**Computer Tomography (CT):**
- X-Ray principles and techniques
- System-theoretical basics (multi-dimensional Fourier transform, sampling, filtering)
- Radon transform
- Fourier-Slice theorem
- CT reconstruction techniques
- Different generations of CT configurations
- X-ray detectors
- Filtered back-projection

**Magnetic resonance imaging (MRI):**
- Principle of MRI
- Physical foundations (Magnetic dipole, proton spin, precession, Lamor frequency, quantum effects, spin-grid and spin-spin relaxation)
- Detection of relaxation constants T1 and T2, spin-echo
- Spatial resolution, selective stimulation, frequency- and phase coding techniques
- Contrast optimization, functional MRI
- Components of an MRI

### Learning Outcome

The students understand the principles and manner of operation of tomographical methods in medicine so they are able to judge (as a precondition for designing) the technical systems necessary for tomographical apparatus. Furthermore they are able to develop new methods and systems in tomography.

### Reading List

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Wide-Bandgap Semiconductors</td>
<td>etit6020-01a</td>
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</table>

**Module Coordinator**

Prof. Dr.-Ing. Holger Kapels

**Organizer**

Institute of Electrical and Information Engineering – Electrical Power Devices

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

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<td>Duration</td>
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<td>Frequency</td>
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<td>Workload per ECTS Credit</td>
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<td>Total Workload</td>
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<tr>
<td>Contact Time</td>
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<td>Independent Study</td>
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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- 

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<td>Exercise</td>
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<th>Evaluation</th>
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<th>Weighting</th>
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<td>Written or Oral Examination</td>
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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

- Semiconductor materials with wide band gap
- Characteristic device parameters (breakdown voltage, area-specific on-resistance)
- SiC Schottky diodes, pin diodes, MPS diodes
- SiC field-effect transistors, cascode circuit, SiC-MOSFETs, SiC-IGBTs
- GaN HEMTs and GaN MOSFETs
- Manufacturing processes
- Measurement method
- Application examples (PFC, resonant converters)

### Learning Outcome

Students can describe the most important wide band gap power semiconductor devices. They know the basic structures, the operating principles as well as the characteristics and the limits of the devices. They can calculate the most important device dimensions and parameters of wide bandgap power semiconductor devices. They can solve typical scientific questions in the design of wide band gap power semiconductor devices. They can appropriately classify the devices according to their fields of application.

### Reading List

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
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<tbody>
<tr>
<td>Seminars</td>
<td>etit7xxx</td>
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**Organizer**
Institute of Electrical Engineering and Information Theory

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering
Module Name | Module Code
--- | ---
Seminar Advanced Topics in Microwave Technologies | etit7001-01a

Module Coordinator
Prof. Dr.-Ing. Michael Höft

Organizer
Institute of Electrical Engineering and Information Theory - Microwave Engineering

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
--- | ---
Evaluation | Not graded
Duration | One Semester
Frequency | Only takes place during summer semesters

Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 30 hours
Independent Study | 120 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
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Recommended Requirements
- 

Module Courses

<table>
<thead>
<tr>
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### Examination(s)

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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

### Course Content

Several advanced topics related to the research area of the Microwave Group, such as:
- THz Integrated Circuits.
- (Sub-)Millimeter-Wave/Quasi-Optical Techniques and Circuity.
- Planar and Waveguide Filters.
- Electronically Tunable Filters.
- Moisture Measurement Techniques.
- RF-Based Security.
- Magnetic Sensors.
- Medical Sensors.
- Radar.
- Data (or Sensor) Fusion for Signal Enhancement.

### Learning Outcome

The students can formulate a research question for independent analysis in the area of advanced topics in microwave technologies. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

Scientific papers relevant to the research topic will be made available to students.
Module Name | Seminar Analysis of Scientific Papers
Module Code | etit7002-01a

Module Coordinator
Prof. Dr. Hermann Kohlstedt

Organizer
Institute of Electrical Engineering and Information Theory – Nano Electronics

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
Evaluation | Not graded
Duration | One Semester
Frequency | Only takes place during winter semesters

Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 45 hours
Independent Study | 105 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements
- Basics in Electronics
- Materials Science Lecture

Module Courses

<table>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

The students’ achievements are assessed in a composite examination.

Course Content

Analysis and understanding of scientific papers related to the questions:
- What is the subject of the paper?
- Which significance the papers has in comparison to others work?
- How plausible are the presented results?
- Are there obvious faults?
- How to read critical a scientific text?

Learning Outcome

Students are able to outline a typical paper in technical or scientific journals and classify papers with respect to journal impact factors. They can research literature unassisted and induct into a novel research and technological subject for preparing a written text to summaries the subject (paper) and the talk. They can critical read scientific paper and have ideas how to write the first own paper.

Reading List

- Guidelines: “How to present a scientific talk” and templates for the talk and the seminar work are available on the Kiel University OLAT learning platform in the material folder of this course.
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<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Seminar Communications</td>
<td>etit7003-01a</td>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. Stephan Pachnicke

**Organizer**
Institute of Electrical Engineering and Information Theory – Communications

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

<table>
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<td>Independent Study</td>
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<td>Teaching Language</td>
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</table>

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
- Knowledge of basics obtained during bachelor's course

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<tr>
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#### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students' achievements are assessed in a composite examination.

#### Course Content

Selected topics of (optical) communications

#### Learning Outcome

The students can formulate a research question for independent analysis in the area of optical communications. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

#### Reading List

- Depending on respective seminar topics.
Module Name | Module Code
-------------|-------------
Seminar Information and Coding Theory | etit7004-01a

Module Coordinator
Prof. Dr.-Ing. Peter A. Höher

Organizer
Institute of Electrical Engineering and Information Theory – Information Theory and Coding

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits | 5
Evaluation | Not graded
Duration | One Semester
Frequency | Every semester
Workload per ECTS Credit | 30 hours
Total Workload | 150 hours
Contact Time | 45 hours
Independent Study | 105 hours
Teaching Language | English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
-

Recommended Requirements
-

Module Courses

<table>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Selected topics in information and coding theory with emphasis on wireless baseband processing, visible light communications, molecular communications, and distributed sensor systems.

Learning Outcome

The students can formulate a research question for independent analysis in the area of information and coding theory. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

Reading List

Literature hints will be given by the supervisor.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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</thead>
<tbody>
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<td>Seminar Integrated Systems and Photonics</td>
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**Module Coordinator**
Prof. Dr. Martina Gerken

**Organizer**
Institute of Electrical Engineering and Information Theory - Integrated Systems and Photonics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits** 5
**Evaluation** Not graded
**Duration** One Semester
**Frequency** Every Semester
**Workload per ECTS Credit** 30 hours
**Total Workload** 150 hours
**Contact Time** 30 hours
**Independent Study** 120 hours
**Teaching Language** English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
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**Recommended Requirements**
-

**Module Courses**

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</table>

**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

**Course Content**

In the seminar current research topics in the area of integrated systems and photonics are presented and discussed. Both students and scientific staff participate in the seminar. Each student studies one research topic under the guidance of a staff member. He/she presents and discusses the topic in the seminar.

**Learning Outcome**

The students can formulate a research question for independent analysis in the area of integrated systems and photonics. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

**Reading List**

- Announced and chosen depending on the research topic.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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</thead>
<tbody>
<tr>
<td>Seminar Nanoelectronics</td>
<td>etit7006-01a</td>
</tr>
</tbody>
</table>

**Module Coordinator**

Prof. Dr. Hermann Kohlstedt

**Organizer**

Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

<table>
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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- Basics in Electronics
- Materials Science Lecture

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/ Optional</th>
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<tbody>
<tr>
<td>Seminar</td>
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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

The students’ achievements are assessed in a composite examination.

### Course Content

Seminar subjects will be announced a month before semester start on the Kiel University OLAT learning platform, typical subjects are in the fields of sensors and sensor technology, device fabrication technology, neuromorphic engineering.

### Learning Outcome

The students can formulate a research question for independent analysis in the area of nanoelectronics. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

- Guidelines for the talk and the preparation of the seminar work are available on the Kiel University OLAT learning platform
Module Name | Module Code
---|---
Seminar on Current Topics in Biomedical Engineering | etit7007-01a

**Module Coordinator**
Prof. Dr.-Ing. Ludger Klinkenbusch

**Organizer**
Institute of Electrical Engineering and Information Theory – Computational Electromagnetics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

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<td>Duration</td>
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**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
-

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
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<td>Seminar on Current Topics in Biomedical Engineering</td>
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### Examination(s)

<table>
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<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

### Course Content

Changing current topics in biomedical engineering

### Learning Outcome

The students can formulate a research question for independent analysis in the area of biomedical engineering. They can perform a literature search and organize publications by relevance. The students can summarize and explain the content of scientific publications. They can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

Depends on the chosen subject, will be provided by the adviser(s).
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Seminar on Selected Topics in Digital Signal Processing</td>
<td>etit7008-01a</td>
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</table>

**Module Coordinator**

Prof. Dr.-Ing. Gerhard Schmidt

**Organizer**

Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

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<td>Duration</td>
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<td>Frequency</td>
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<td>Workload per ECTS Credit</td>
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**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- Fundamentals in digital signal processing

**Recommended Requirements**

- Fundamentals in digital signal processing

**Module Courses**

<table>
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<tr>
<th>Course Type</th>
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### Examination(s)

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<th>Evaluation</th>
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<th>Weighting</th>
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**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

The students’ achievements are assessed in a composite examination.

### Course Content

Students prepare a written scientific report based on literature research. They also present their findings to the other participants in form of an oral presentation. The seminar topics are closely related to the current research topics of the Digital Signal Processing and System Theory group.

### Learning Outcome

The students can formulate a research question for independent analysis in the area of digital signal processing. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

Initial reading list provided with seminar topic.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Seminar on Selected Topics in Systems and Control</td>
<td>etit7009-01a</td>
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</table>

**Module Coordinator**
Prof. Dr.-Ing. habil. Thomas Meurer

**Organizer**
Institute of Electrical Engineering and Information Theory – Automatic Control

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits** 5

**Evaluation** Not graded

**Duration** One Semester

**Frequency** Only takes place during summer semesters

**Workload per ECTS Credit** 30 hours

**Total Workload** 150 hours

**Contact Time** 30 hours

**Independent Study** 120 hours

**Teaching Language** English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- **Recommended Requirements**
Knowledge in nonlinear and optimal control corresponding to modules etit5013-01a and etit5015-01a

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>Seminar</td>
<td>Seminar on Selected Topics in Systems and Control</td>
<td>Compulsory</td>
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<th>Evaluation</th>
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<th>Weighting</th>
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<tr>
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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

### Course Content

In the seminar current research topics in systems and control are considered.

### Learning Outcome

The students comprehend advanced control and observer design methods. They can independently review and organize existing literature. They can summarize and explain the content of the scientific publications. The students can compare the results, can design and evaluate controllers for nonlinear systems, and can assess them critically. They know presentation techniques and have developed presentation skills. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

Will be announced during the seminar.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Seminar Power Electronics</td>
<td>etit7010-01a</td>
</tr>
</tbody>
</table>

**Module Coordinator**

Prof. Dr.-Ing. Marco Liserre

**Organizer**

Institute of Electrical Engineering and Information Theory – Power Electronics

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits**

5

**Evaluation**

Not graded

**Duration**

One Semester

**Frequency**

Only takes place during winter semesters

**Workload per ECTS Credit**

30 hours

**Total Workload**

150 hours

**Contact Time**

30 hours

**Independent Study**

120 hours

**Teaching Language**

English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- 

**Module Courses**

<table>
<thead>
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### Examination(s)

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<td>Power Electronics</td>
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#### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

The students’ achievements are assessed in a composite examination.

#### Course Content

The students will investigate a scientific or technical problem by means of several publications and collect, reproduce and evaluate the material in a seminar paper. Possible fields of interest are:

- Power semiconductors
- Power electronic circuits
- Electric drives
- Control of electric drives
- Renewable energy production

#### Learning Outcome

The students can formulate a research question for independent analysis in the area of power electronics. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

#### Reading List

Will be given with the topic
### Module Name
Seminar Selected Topics in Medical Electronics

### Module Code
etit7012-01a

### Module Coordinator
Prof. Dr.-Ing. Andreas Bahr, Prof. Robert Rieger, Ph.D.

### Organizer
Institute of Electrical and Information Engineering – Sensor System Electronics
Institute of Electrical and Information Engineering – Networked Electronic Systems

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

<table>
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<td>Workload per ECTS Credit</td>
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<td>Independent Study</td>
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### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations
-  

### Recommended Requirements
-  

### Module Courses

<table>
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<tr>
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<th>Course Name</th>
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### Examination(s)

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</table>

**Further Information on the Examination(s)**

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students' achievements are assessed in a composite examination.

### Course Content

Selected current topics from all fields of medical electronics

### Learning Outcome

The students can formulate a research question for independent analysis in the area of medical electronics. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

### Reading List

- Will be announced in the seminar based on the actual topics

### Additional Information

Stake in the module
- Sensor System Electronics: 50 %
- Networked Electronic Systems: 50 %
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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<tbody>
<tr>
<td>Seminar X-ray Diffraction Methods for Thin Film Analysis</td>
<td>etit7011-01a</td>
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**Module Coordinator**
Prof. Dr. Hermann Kohlstedt, Dr. Adrian Petraru

**Organizer**
Institute of Electrical Engineering and Information Theory – Nano Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Not graded

**Duration**
One Semester

**Frequency**
Every winter and summer semester

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
45 hours

**Independent Study**
105 hours

**Teaching Language**
English

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
Materials Science Lecture

**Module Courses**

<table>
<thead>
<tr>
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<td>Seminar</td>
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Examination(s)

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<th>Weighting</th>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Fundamentals:
- Basics of X-Ray optics: X-Ray tubes, X-Ray detectors, monochromators, Soller slits, Göbel mirrors
- Elements of crystallography, Introduction to X-Ray diffraction techniques for thin film analysis

X-ray diffraction methods:
- The normal theta-two theta scan
- The phi scan
- Rocking curve (omega scan)
- Texture Measurement (Pole Figure)
- X-Ray Reflectivity
- X-ray reciprocal space mapping

Learning Outcome

The students can formulate a research question for independent analysis in the area of X-ray diffraction methods for thin film analysis. The students can perform a literature search and organize publications by relevance. They can summarize and explain the content of the scientific publications. The students can compare the results and assess them critically. The students can present the results, discuss them and recommend further research steps on the research topic.

Reading List

- Paul F. Fewster, X-ray scattering from semiconductors, Imperial college Press, London
<table>
<thead>
<tr>
<th>Name</th>
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**Organizer**
Institute of Electrical Engineering and Information Theory

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering
<table>
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<th>Module Name</th>
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<td>M.Sc. Laboratory Advanced Control</td>
<td>etit8001-01a</td>
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**Module Coordinator**

Prof. Dr.-Ing. habil. Thomas Meurer

**Organizer**

Institute of Electrical Engineering and Information Theory – Automatic Control

**Faculty**

Faculty of Engineering

**Examination Office**

Examination Office Electrical and Information Engineering

**ECTS Credits** 5

**Evaluation** Not graded

**Duration** One Semester

**Frequency** Only takes place during winter semesters

**Workload per ECTS Credit** 30 hours

**Total Workload** 150 hours

**Contact Time** 60 hours

**Independent Study** 90 hours

**Teaching Language** English

**Further Information on the Teaching Language**

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**

- 

**Recommended Requirements**

- Nonlinear Control Systems (Module etit5013-01a)

**Module Courses**

<table>
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<tr>
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<tr>
<td>Colloquia, Practical Tasks and Protocols: M.Sc. Laboratory Advanced Control</td>
<td>Colloquia, Practical Tasks and Protocols</td>
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Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Experiments addressing the themes:
- Mathematical modeling and control design using computer-algebra-systems
- Computer-assisted nonlinear control design (primary focus of laboratory)
- Implementation and experimental validation

Learning Outcome

The students have an in-depth understanding of computer-assisted modeling and control design methods for nonlinear systems. They understand the underlying mathematical and algorithmic concepts and are able to apply these to new practical problems. The students are able build and analyze simulation models. They have the ability to implement nonlinear controllers using symbolic and numerical computational tools taking into account real-time aspects.

Reading List

### Module Name
M.Sc. Laboratory Communications

<table>
<thead>
<tr>
<th>Module Code</th>
<th>etit8002-01a</th>
</tr>
</thead>
</table>

### Module Coordinator
Prof. Dr.-Ing. Stephan Pachnicke

### Organizer
Institute of Electrical Engineering and Information Theory – Communications

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Not graded

### Duration
One Semester

### Frequency
Only takes place during summer semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
60 hours

### Independent Study
90 hours

### Teaching Language
English

### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations
- 

### Recommended Requirements
Knowledge of basics obtained during bachelor's course

### Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/ Optional</th>
<th>SWS</th>
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</thead>
<tbody>
<tr>
<td>Practical Exercise</td>
<td>M.Sc. Laboratory Communications</td>
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</table>
Examination(s)

<table>
<thead>
<tr>
<th>Examination Name</th>
<th>Type of Examination</th>
<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
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<tbody>
<tr>
<td>Colloquia and Practical Tasks: M.Sc. Laboratory Communications</td>
<td>Colloquia and Practical Tasks</td>
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</tr>
</tbody>
</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Hands-on experiments and computer simulations (MATLAB) on selected topics in communications and related fields:

1. Introduction to MATLAB
2. LTI-Systems: State Equations and Simulation
3. PAM/PCM
4. Optical/Digital Modulation
5. Erbium-doped fiber amplifier (EDFA)
6. Equalization
7. Correlation, Coherence and Information Flow
8. Signal Sources and Spectrum Analysis
9. Source Coding: Data Compression Using the Huffman and the Lempel-Ziv Algorithm
10. Cryptology: Encryption and Authentication Using the RSA Algorithm
11. Optical Communication Basics

Learning Outcome

The students gain practical expertise with signals, systems, and analysis methods for digital communications, by means of computer-based and instrumental measurement experiments. They have gained experience with both electrical and optical systems. They know how to implement basic digital signal processing in MATLAB.

Reading List

- During the lab course, a set of references is given for each experiment.
- Manuals are available for all experiments.
Module Name
M.Sc. Laboratory Digital Circuit Design

Module Code
etit8009-01a

Module Coordinator
Prof. Dr.-Ing. Andreas Bahr

Organizer
Institute of Electrical and Information Engineering – Sensor System Electronics

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

ECTS Credits
5

Evaluation
Not graded

Duration
One Semester

Frequency
Only takes place during winter semesters

Workload per ECTS Credit
30 hours

Total Workload
150 hours

Contact Time
60 hours

Independent Study
90 hours

Teaching Language
English

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
-

Recommended Requirements
-

Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<tbody>
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Examination(s)

<table>
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<th>Examination Name</th>
<th>Type of Examination</th>
<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report and Presentation: M.Sc. Laboratory Digital Circuit Design</td>
<td>Report and Presentation</td>
<td>Graded</td>
<td>Compulsory</td>
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</tbody>
</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

Course Content

- Introduction into Hardware Description Languages (VHDL/Verilog).
- Fundamentals of digital circuit design: FPGAs, Integrated circuits, standard cells
- Specifications and Architectures
- Digital Design Flow
- Behavioral Simulation
- Design Implementation
- Timing Simulation

Learning Outcome

The students have an in-depth understanding of the design of digital circuits for integrated circuits and FPGA as well as the design techniques and procedures. They know the major methods of design and simulation of digital circuits for FPGA and integrated circuits. The students know how to simulate the functionality and consider e.g. timing aspects during the development phase. They can use this knowledge to create new digital designs and enhance existing digital designs for FPGA and integrated circuits.

Reading List


Further reading material will be announced during the course based on the actual topic.
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Sc. Laboratory Examples in Computerized IC Testing</td>
<td>etit8008-01a</td>
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</table>

**Module Coordinator**
Prof. Robert Rieger, Ph.D.

**Organizer**
Institute of Electrical and Information Engineering – Networked Electronic Systems

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

<table>
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<td>Duration</td>
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<td>Frequency</td>
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<td>Workload per ECTS Credit</td>
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<td>Total Workload</td>
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<td>Contact Time</td>
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<tr>
<td>Independent Study</td>
<td>90 hours</td>
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<tr>
<td>Teaching Language</td>
<td>English</td>
</tr>
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</table>

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
-

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/Optional</th>
<th>SWS</th>
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</thead>
<tbody>
<tr>
<td>Practical Exercise</td>
<td>M.Sc. Laboratory Examples in Computerized IC Testing</td>
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<tr>
<td>Seminar</td>
<td>M.Sc. Laboratory Examples in Computerized IC Testing</td>
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Examination(s)

<table>
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<tr>
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<th>Type of Examination</th>
<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Sc. Laboratory Examples in Computerized IC Testing: Report or Oral Examination</td>
<td>Report or Oral Examination</td>
<td>Not Graded</td>
<td>Compulsory</td>
<td>-</td>
</tr>
</tbody>
</table>

Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Course Content

Gaining practical experience in the measurement and evaluation of integrated circuits is the focus of this module. It is intended to generate understanding for improved design planning with regard to the testability of integrated circuits. Various commercially relevant approaches to computer-based testing will be presented and experienced in practice. In particular, the hardware/software combination of National Instruments Labview+DAQ is used for signal generation and acquisition, Microchip microcontrollers are programmed for test signal generation, digital pattern generation and signal recording, and PCB layouts are created with Diptrace or Eagle design software. PC-based oscilloscopes from Picoscope Inc. are used for mixed-signal monitoring. Examples of practical group work packages are as follows.

- Labview signal generation+measurement - analog: OPA transfer function
- Labview Signal generation+measurement - digital: Counter Frequency measurement
- Microcontroller: ADC+DAC, temperature measurement, SPI interface
- PCB design + manufacturing

Learning Outcome

The students will be familiar with the standard testing solutions provided by NI Labview DAQ, Picoscope, and MPLab and have the essential application skills. They gain experience with practical bench test setup and computer supported testing of electronics hardware so that they are able to apply their knowledge independently on other testing tasks. The students have the ability to read and interpret datasheets and instruction manuals and apply the information independently.

Reading List

- Lab instruction materials (handouts)
- User manuals for Labview, MPLab IDE, Picoscope
- Datasheet for Microchip microcontroller
## Module Name

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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</thead>
<tbody>
<tr>
<td>M.Sc. Laboratory Information Processing</td>
<td>etit8003-01a</td>
</tr>
</tbody>
</table>

## Module Coordinator

Prof. Dr.-Ing. Peter A. Höher

## Organizer

Institute of Electrical Engineering and Information Theory – Communications
Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory
Institute of Electrical Engineering and Information Theory – Information Theory and Coding

## Faculty

Faculty of Engineering

## Examination Office

Examination Office Electrical and Information Engineering

## ECTS Credits

| ECTS Credits | 5 |

## Evaluation

Not graded

## Duration

One Semester

## Frequency

Only takes place during winter semesters

## Workload per ECTS Credit

<table>
<thead>
<tr>
<th>Workload per ECTS Credit</th>
<th>30 hours</th>
</tr>
</thead>
</table>

## Total Workload

150 hours

## Contact Time

60 hours

## Independent Study

90 hours

## Teaching Language

English

### Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

- 

### Recommended Requirements

- 

## Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/Optional</th>
<th>SWS</th>
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</thead>
<tbody>
<tr>
<td>Practical Exercise</td>
<td>M.Sc. Laboratory Information Processing</td>
<td>Compulsory</td>
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### Examination(s)

<table>
<thead>
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<th>Examination Name</th>
<th>Type of Examination</th>
<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
</tr>
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<tbody>
<tr>
<td>Colloquia and Practical Tasks: M.Sc. Laboratory Information Processing</td>
<td>Colloquia and Practical Tasks</td>
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<td>Compulsory</td>
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</table>

### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

At the beginning of the winter term, selected topics in digital communications, signal processing, and information technology will be announced. The topics are subject to vary from year to year. Teams of up to four students will select a single topic. During the entire semester, the teams will work on their topic. Typically, this involves software development. Supervision is provided. By the end of the winter semester, a team-wise presentation is given within a one-day workshop.

### Learning Outcome

The students acquire the ability to do a literature search on a given scientific topic, to evaluate this literature, and to extract central points. Furthermore, the students learn to implement their topic in a high-level language (e.g., MATLAB, C/C++, or Java). Finally, the students learn to work in a team and to give a presentation. After successful completion, they can critically assess latest developments in selected topics.

### Reading List

Literature hints will be given by the supervisor. This literature is tailored to the selected topic.

### Additional Information

Stake in the module:
- Communications: 33.33 %
- Digital Signal Processing and System Theory: 33.33 %
- Information Theory and Coding: 33.33 %
<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
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</thead>
<tbody>
<tr>
<td>M.Sc. Laboratory Microwave Technology and Electromagnetic Compatibility</td>
<td>etit8004-01a</td>
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</tbody>
</table>

**Module Coordinator**
Dr.-Ing. Frank Daschner

**Organizer**
Institute of Electrical Engineering and Information Theory - Microwave Engineering

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

<table>
<thead>
<tr>
<th>ECTS Credits</th>
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</thead>
<tbody>
<tr>
<td>Evaluation</td>
<td>Not graded</td>
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<tr>
<td>Duration</td>
<td>One Semester</td>
</tr>
<tr>
<td>Frequency</td>
<td>Only takes place during winter semesters</td>
</tr>
<tr>
<td>Workload per ECTS Credit</td>
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<tr>
<td>Total Workload</td>
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<tr>
<td>Contact Time</td>
<td>60 hours</td>
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<tr>
<td>Independent Study</td>
<td>90 hours</td>
</tr>
<tr>
<td>Teaching Language</td>
<td>English</td>
</tr>
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</table>

**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
- 

**Recommended Requirements**
- Knowledge about microwave technology and electromagnetic compatibility of a B.Sc.
- Lectures regarding radio and microwave frequencies

**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/ Optional</th>
<th>SWS</th>
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<tbody>
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<td>M.Sc. Laboratory Microwave Technology and Electromagnetic Compatibility</td>
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### Examination(s)

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<th>Compulsory/Optional</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colloquia, Practical Tasks and Protocols: M.Sc. Laboratory Microwave Technology and Electromagnetic Compatibility</td>
<td>Colloquia, Practical Tasks and Protocols</td>
<td>Graded</td>
<td>Compulsory</td>
<td>-</td>
</tr>
</tbody>
</table>

### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

1. Mixer
2. Phase noise of oscillators
3. Reflectometer with rectangular waveguides
4. Microwave sensors: Permittivity measurements with transmission in free space
5. Dimensioning and matching of antennas
6. Controllable antennas
7. Propagation of waves
8. Shielding of cases
9. Transmission lines and cables (analysis, shielding)
10. Measurement of transmission line emissions

### Learning Outcome

The students have an in-depth understanding about the application of electromagnetic field simulators and measurement instruments. They are able to solve given problems on microwave technology and electromagnetic compatibility. They perform related simulations and measurements. They can verify the theoretical models with measurements. They summarize the results in a report.

### Reading List

Literature is suggested within the experimental instructions
Module Name | Module Code
---|---
M.Sc. Laboratory Optoelectronics | etit8005-01a

Module Coordinator
Prof. Dr. Martina Gerken

Organizer
Institute of Electrical Engineering and Information Theory - Integrated Systems and Photonics

Faculty
Faculty of Engineering

Examination Office
Examination Office Electrical and Information Engineering

| ECTS Credits | 5 |
| Evaluation | Not graded |
| Duration | One Semester |
| Frequency | Every semester |
| Workload per ECTS Credit | 30 hours |
| Total Workload | 150 hours |
| Contact Time | 45 hours |
| Independent Study | 105 hours |
| Teaching Language | English |

Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations
- 

Recommended Requirements
- Solid state physics
- Semiconductor devices

Module Courses
<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/Optional</th>
<th>SWS</th>
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<tbody>
<tr>
<td>Practical Exercise</td>
<td>M.Sc. Laboratory Optoelectronics</td>
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### Examination(s)

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<th>Evaluation</th>
<th>Compulsory/Optional</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colloquia, Practical Tasks, Reports and Presentation: M.Sc. Laboratory Optoelectronics</td>
<td>Colloquia, Practical Tasks, Reports and Presentation</td>
<td>Not graded</td>
<td>Compulsory</td>
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</table>

### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

Note that you have to pass the module "Photonic Components" (etit6015-01a) or the module "B.Sc. Laboratory Micro-Nano-Optosystems" (etit-311 "Bachelorpraktikum Mikro-Nano-Optosystemtechnik") prior to registering for the M.Sc. Laboratory Optoelectronics.

### Course Content

The laboratory teaches theoretical and practical knowledge in the fabrication and characterization of optoelectronic devices based on organic semiconductor materials. In the laboratory, organic light emitting diodes (OLEDs) and organic photo diodes (OPDs) are fabricated and characterized. The students design the devices and perform the fabrication steps independently in small groups under staff guidance in the Kieler Nano Lab. The characterization is performed by the students in the optical laboratories of the Chair for Integrated Systems and Photonics.

### Learning Outcome

The students can implement fabrication procedures in a clean-room environment. They can perform literature searches for specific design tasks. They can design an optoelectronic device and develop a new fabrication procedure. They can conduct experimental characterization procedures for optoelectronic devices and prepare experiment protocols. They can assess the results critically and present and discuss their results.

### Reading List

**Mandatory reading**
- Instructions for experiments and scientific publications

**Further reading**
- Independent further literature search.
**Module Name**
M.Sc. Laboratory Power Electronics - Renewable Energy - Drive Engineering

**Module Code**
etit8006-01a

**Module Coordinator**
Prof. Dr.-Ing. Marco Liserre

**Organizer**
Institute of Electrical Engineering and Information Theory – Power Electronics

**Faculty**
Faculty of Engineering

**Examination Office**
Examination Office Electrical and Information Engineering

**ECTS Credits**
5

**Evaluation**
Not graded

**Duration**
One Semester

**Frequency**
Only takes place during winter semesters

**Workload per ECTS Credit**
30 hours

**Total Workload**
150 hours

**Contact Time**
75 hours

**Independent Study**
75 hours

**Teaching Language**
English

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**Further Information on the Teaching Language**
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

**Entry Requirements as Stated in the Examination Regulations**
-

**Recommended Requirements**
-

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**Module Courses**

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
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<tbody>
<tr>
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### Examination(s)

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<tr>
<td>Colloquia, Practical Tasks and Protocols: M.Sc. Laboratory Power Electronics - Renewable Energy - Drive Engineering</td>
<td>Colloquia, Practical Tasks and Protocols</td>
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</table>

### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

Laboratory exercises for power electronics, renewable energies, and drive technologies

### Learning Outcome

The students learns abilities to measure electrical quantities in experimental evaluations and they are able to analyze these measurement results for essential power electronic, renewable energy, and drive technology systems. The students can formulate theories and apply solutions formulated by themselves to solve specific technical problems.

### Reading List

### Module Name
M.Sc. Laboratory Real-time Signal Processing

### Module Code
etit8007-01a

### Module Coordinator
Prof. Dr.-Ing. Gerhard Schmidt

### Organizer
Institute of Electrical Engineering and Information Theory – Communications
Institute of Electrical Engineering and Information Theory – Digital Signal Processing and System Theory
Institute of Electrical Engineering and Information Theory – Information Theory and Coding

### Faculty
Faculty of Engineering

### Examination Office
Examination Office Electrical and Information Engineering

### ECTS Credits
5

### Evaluation
Not graded

### Duration
One Semester

### Frequency
Only takes place during summer semesters

### Workload per ECTS Credit
30 hours

### Total Workload
150 hours

### Contact Time
60 hours

### Independent Study
90 hours

### Teaching Language
English

### Further Information on the Teaching Language
The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

### Entry Requirements as Stated in the Examination Regulations

#### Recommended Requirements
Knowledge of basics obtained during bachelor course

### Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
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<th>Compulsory/ Optional</th>
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<tbody>
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<td>M.Sc. Laboratory Real-time Signal Processing</td>
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<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical Task, Presentation and Paper: M.Sc. Laboratory Real-time Signal Processing</td>
<td>Practical Task, Presentation and Paper</td>
<td>Graded</td>
<td>Compulsory</td>
<td>-</td>
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</table>

### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT. The students’ achievements are assessed in a composite examination.

### Course Content

At the beginning of the lab students obtain an introduction into the hard- and software platform they will use during the lab. Afterwards they will obtain real-world signal processing problems or topics such as:
- noise suppression for speech signals,
- equalization of loudspeakers,
- software-defined radio, or
- software-defined optics

which they should solve or implement with the tools mentioned above in small teams. At the end of the lab each group should give a short presentation about their platform as well as their problem and their solution.

### Learning Outcome

Students can design and program “robust” signal processing structures. They understand the impacts of basic building blocks of a signal processing systems on the choice of algorithms. Students apply efficient processing structures. They organize and split their work in in small teams. Students compare different statistical optimization approaches.

### Reading List

During the seminar, a set of references is given for each lab topic.

### Additional Information

Stake in the module:
- Communications: 33.33 %
- Digital Signal Processing and System Theory: 33.33 %
- Information Theory and Coding: 33.33 %
Module Name

M.Sc. Project Power Electronics, Control and Communications in Energy Systems

Module Code

etit9001-01a

Module Coordinator

Prof. Dr.-Ing. Marco Liserre

Organizer

Institute of Electrical Engineering and Information Theory – Power Electronics
Institute of Electrical Engineering and Information Theory – Automatic Control
Institute of Electrical Engineering and Information Theory – Communications

Faculty

Faculty of Engineering

Examination Office

Examination Office Electrical and Information Engineering

ECTS Credits

10

Evaluation

Not graded

Duration

One Semester

Frequency

Only takes place during winter semesters

Workload per ECTS Credit

30 hours

Total Workload

300 hours

Contact Time

150 hours

Independent Study

150 hours

Teaching Language

English

Further Information on the Teaching Language

The language of instruction is English. This module is suitable for students with English language skills according to the Common European Framework (CEF) level B2.

Entry Requirements as Stated in the Examination Regulations

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Recommended Requirements

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Module Courses

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Course Name</th>
<th>Compulsory/Optional</th>
<th>SWS</th>
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</thead>
<tbody>
<tr>
<td>Project</td>
<td>M.Sc. Project Power Electronics, Control and Communications in Energy Systems</td>
<td>Compulsory</td>
<td>10</td>
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### Examination(s)

<table>
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<tr>
<th>Examination Name</th>
<th>Type of Examination</th>
<th>Evaluation</th>
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<tr>
<td>M.Sc. Project Power Electronics, Control and Communications in Energy Systems: Presentation and Report</td>
<td>Presentation and Report</td>
<td>Not graded</td>
<td>Compulsory</td>
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### Further Information on the Examination(s)

Further information on the examinations offered by the Institute of Electrical Engineering and Information Technology (EE&IT) can be found on the website of the Examination Office EE&IT.

### Course Content

Project Based Learning involving a Seminar and a Laboratory part of at least two of the following areas

- Power Electronics
- Control and Communications

### Learning Outcome

The student learns the ability to approach a multidisciplinary topic and to do teamwork in order to solve the given task. The students can re-elaborate the approached topic and present it through a report and a presentation on the subject.

### Reading List

- Topic dependent and it will provided at the beginning of the project.

### Additional Information

Stake in the module:
- Automatic Control: 33.33 %
- Communications: 33.33 %
- Power Electronics: 33.33 %