Module guide

Module Guide M.Sc. CIT & M.Sc. CMM (MPO 2019)

This module guide details the contents of the master's programmes CIT and CMM for informational purposes. Binding rules are set out by the specific examination regulations.

Overview classified by module groups

1. CIT Core Modules (compulsory)

Students accumulate 66 credit points plus 30 credit points for the Master Thesis.

2. CMM Core Modules (compulsory)

Students accumulate 66 credit points (including Lab1 and Lab2) plus 30 credit points for the Master Thesis.

2. 1. CMM Options Lab1 + Lab 2

3. CIT & CMM Elective Modules

Students accumulate 24 CP in elective modules from semester 1 through 3.

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Alphabetical module list

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Module 01-15-03 ADSP: Advanced Digital Signal Processing
Advanced Digital Signal Processing
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:
- Linear MMSE and Least Square Estimation (Theory and Algorithms).
- Adaptive Filtering (LMS, NLMS, Affine Projection, RLS)
- Estimation of power spectrum density (estimation of autocorrelation function, periodogram, Bartlett-Welch method)
- Parametric estimation of power spectrum density
- Development of simulation models using Matlab
- Linear Algebra
- Principle Component Analysis
- Compressed Sensing
- Finite Rate of Innovation
- Kalman Filter

Learning outcome / Competence:
After the course, the students will be able to

- understand the basics of linear estimation theory and algorithms (MMSE, Least Square);
- understand adaptive filters (LMS, NLMS, Affine projection, RLS);
- explain the basics of the traditional methods of spectral analysis for stochastic processes;
- understand the theoretical basics of parametric estimation procedures;
- develop and apply existing MATLAB routines;
- understand the basics of linear algebra and data/signal representation;
- understand the basics of sampling below the Nyquist rate with advanced methods such as compressed sensing and finite rate of innovation;
- understand advanced filtering methods such as the Kalman filter.

Calculating student workload:
The module comprises a lectures, exercises and laboratory exercises of 4 credit hours:

- Contact hours (lectures and exercises): 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof.Dr.-Ing. Armin Dekorsy
	Dr.-Ing. Carsten Bockelmann

Frequency:	Duration:
WiSe, once a year	1 semester[s]

The module is valid since:	The module is valid until:
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Prüfungsleistung
Oral	

Module courses

Course:	01-15-03-ADSP-V Advanced Digital Signal Processng
Frequency:	**Are there parallel courses?**
WiSe, once a year	no
Language:	**University teacher(s):**
English	Bockelmann, Carsten, Dr.-Ing.
	Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s):	**Associated module examination:**
Lecture	Modulprüfung
Tutorial	

Module 01-15-03 CCod(a): Channel Coding
Channel Coding
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	Basics of Communication Technologies or equivalent

Learning content:
- Information Theory
- Blockcodes
- Convolutional Codes
- Concatenated Codes

Learning outcome / Competence:

After this course, the students should be able to

- understand the fundamentals of information theory and the concept of channel coding;
- understand the fundamentals of block and convolutional codes;
- apply encoding and decoding algorithms;
- understand the concept of concatenated codes and iterative decoding.

Calculating student workload:

The module comprises a lecture with exercises of 2 credit hours:

- Contact hours (lectures and exercises): 28 h (2 h x 14 weeks)
- Preparation, learning and exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Dr.-Ing. Dirk Wübben
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-CCod(a)-V Channel Coding
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Wübben, Dirk, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 CNS(a): Communication Networks
Communication Networks
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:

Distributed Systems, ISO/OSI 7 Layer Reference Model for Open Communication, Formal Specification Methods for Protocols (SDL), Data Link Layer, Network Layer, Transport Layer, Application Oriented Layers, Local Area Networks, Wide Area Networks, Network Control: (virtual) connections, Routing, Addressing, Flow Control, System Examples: TCP/IP, Wireless LAN, opportunistic and delay-tolerant networks.

Theoretical foundations of networking; queuing theory; graph theory, linear programming, network simulation basics.

Learning outcome / Competence:

The participants are able to describe exemplary systems of communication networks, name and explain the layers of a communication network, know the basic technologies used for communication protocols, know basic error handling mechanisms for communication protocols. The participants can analyze different network topologies and perform basic performance analysis of network protocols.

Calculating student workload:

The module comprises a lecture including exercises of 3 credit hours.

Workload:

- Contact hours (lectures + exercises): 42 h (3 h x 14 weeks)
- Preparation, self-learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 82 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	3 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Announcement at the begin of the semester	Successful assessment of homework assignments and a successful project preparation and presentation thereof or written exam.

Module courses

Course:	01-15-03-CNS(a) Communication Networks
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Könsgen, Andreas, Dr. Förster, Anna, Prof. Dr.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 01-15-03 ED(a): Electrodynamics
Electrodynamics
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:

Without Electrodynamics, without the theory of Maxwell, Faraday, Ampere, Oersted, et al. about electric, magnetic, and electromagnetic phenomena like conduction, induction, and electromagnetic fields and waves, our modern world with all its achievements in electricity, electronics and communications would not exist. This course gives an understanding about the theory in the field of electrodynamics. The focus is on the discussion of Maxwell's equations and electromagnetic wave phenomena.

- Mathematical background of electrodynamics (scalar and vector fields, vector operations grad, div, curl, complex notation)
- Maxwell's equations
- Boundary conditions
- Electromagnetic wave equation and their solutions
- Polarization of electromagnetic waves
- Poynting vector field

References:

- Lecture script and slides
- Matthew Sadiku, "Elements of Electromagnetics", Oxford University Press, 2007.
- John Jackson, "Classical Electrodynamics", John Wiley & Sons, third edition, 1998.
- David Pozar, "Microwave Engineering," John Wiley & Sons, third or fourth edition.

Learning outcome / Competence:

After this course the students should be able

- to explain electromagnetic phenomena with the help of Maxwell's equations;
- to derive the boundary conditions at an interface of two different media;
- to derive the wave equation, to give their solutions and to interpret them;
- to explain the different types of polarization (linear, ellipical, circular, left-handed, right-handed);
- to explain the basics of antennas;
- to calculate the radiated fields of a Hertzian dipole.

Calculating student workload:

The module comprises a lecture, exercises and laboratory exercises of 4 credit hours:

- Contact hours (lectures and exercises): 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Martin Schneider

Frequency:	Duration:
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-ED(a)-V Electrodynamics
Frequency:	**Are there parallel courses?**
SoSe, once a year	no
Language:	**University teacher(s):**
English / German	Schneider, Martin, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**
Lecture	Modulprüfung
Tutorial	

Module 01-15-03 LC(a): Language Course
Language Course
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory) • CMM Core Modules (compulsory)	none

Learning content:

Depending on their command of the German language students select basic or intermediate language classes. The German language course is organized by Fremdsprachenzentrum Bremen (FZHB) and taught by the Goethe Institute Bremen using the methods of language teaching. The course is mandatory. The students are asked to approach the master office CIT/CMM for details. The courses are advertised in the online course catalogue and on the web pages of FZHB at the start of each semester.

Learning outcome / Competence:

The aim of the (German) language course is to achieve a basic understanding of German. After the course, the students should be able to communicate in German for the needs of everyday life. They should also be able to understand scientific and management topics so that they can follow the discussions in a research institute.

Students with German as mother tongue or German language skills corresponding to level C1 approach their examination board to asses their individual requirements.

Calculating student workload:

Contact hours: 56 h (4 h x 14 weeks)

Preparation, learning and exercises: 124 h

Total working hours: 180 h

Language of tuition:	Module leader:
German	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
WiSe, SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Studienleistung

Module 01-15-03 NetSimT: Network Simulation Theory
Network Simulation Theory
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:
- Discrete Event Simulation
- Radio transmission models
- Mobility models
- Traffic generation
- Interference models
- Power consumption and battery models
- OMNeT++
- Simulation speedup

A list of references will be provided at the start of the semester.

Learning outcome / Competence:
none

Calculating student workload:

The module follows a blended learning approach, with 2 contact hours per week.

Workload:

- Contact hours: 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 42 h (3 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Announcement at the begin of the semester	Homework assignments, e-examination

Module courses

Course:	01-15-03-NetSimT-V Network Simulation Theory
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Förster, Anna, Prof. Dr.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 01-15-03 RFC(a): RF Frontend Devices and Circuits
RF Frontend Devices and Circuits
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:

- Two-port circuits
- Noise in electronic circuits (thermal noise, noise figure, noise temperature, Friis formula, antenna noise, etc.)
- Fundamentals of non-linear devices (gain compression, desensitization, IP2, IP3 points, …)
- RF devices & RF circuits and frontends (amplifier, mixer, oscillator)

A list of references is given in the manuscript.

Learning outcome / Competence:

After successful completion of this module the students:

- can describe two-port circuits by matrices (Z, Y, ABCD, …)
- know the basic schematics of typical transmitter and receiver circuits
- can analyze the noise performance of receiver circuits
- can perform a signal and noise budget analysis of typical wireless communication links (microwave backhaul systems, mobile communications, satellite communications)
- can analyze the non-linear behavior of practical RF devices (amplifier, mixer)
- can design and analyze fundamental oscillator topologies
- are able to discuss the pros and cons of different RF frontend architectures and can design first basic analogue RF frontend circuits.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Martin Schneider
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-RFC(a)-V RF Frontend Devices and Circuits
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schneider, Martin, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 Wcom(a): Wireless Communications
Wireless Communications
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	Basics of Communication Technologies or equivalent

Learning content:
- Stochastic description of Mobile Radio Channels
- Time/Frequency Diversity Techniques
- Multi-Carrier-Systems (Filterbank Modulated, OFDM)
- Code-Division-Multiple Access (e.g. DS-CDMA)

A list of references will be provided at the start of the semester.

Learning outcome / Competence:
After this course, the students will be able to

- understand the fundamentals of mobile communication channels (Doppler-Spread, Delay-Spread, Angular-Spread, Frequency and time selectivity) as well as channel models (Rice/Rayleigh fading);
- explain the concept of communication diversity and related techniques;
- understand the principles of mapping information onto F/T-grids, to explain the ambiguity function, inter-carrier and inter-symbol-interference, to design multi-carrier-systems like OFDM, FBMC);
- understand the principle of separating signals in the code domain, to explain the design of (composite) spreading sequences, and to design CDMA receivers used in modern communication systems.

Calculating student workload:
The module comprises a lecture, exercises and laboratory exercises of 4 credit hours:

- Contact hours: 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180h

Language of tuition:	Module leader:
English	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-WCom(a)-V Wireless Communications
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 IKT1: Praktikum Informations- und Kommunikationstechnik I (IKT I) / Information and Communication Technolo
Information and Communication Technology Laboratory I (IKT I)
MPO 2015

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:
The laboratory course "Information and Communication Technology Laboratory I" is meant to provide the hands-on experience for the topics of the lectures offered by the Institute of Telecommunications and High Frequency Techniques. The module allows students to acquire the knowledge concerning the practical application of communication technology methods through labs on RF design, Communication Networks and Communication Technologies.

Learning outcome / Competence:
The students are able to apply theoretical knowledge and to interpret and document measurement results. They get to know modern simulating tools and measuring instruments.

Calculating student workload:
- Contact hours (experiments): 28 h (2 h x 14 weeks)
- Preparation and follow-up: 28 h (2 h x 14 weeks)
- Reports: 34 h

Total workload: 90 h

Language of tuition:	Module leader:
English / German	Prof.Dr.-Ing. Armin Dekorsy
	Dr.-Ing. Carsten Bockelmann, Prof. Dr.-Ing. Martin Schneider, Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 15/16	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Versuchsdurchführungen und Versuchsprotokolle
Pratical course	(Portfolio)

Module courses

Course:	01-15-03-IKT1-P Information and Communication Technology Laboratory
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):**
Teaching method(s): Laboratory class	**Associated module examination:**

Module 01-15-03 IKT2: Praktikum Informations- und Kommunikationstechnik II (IKT II) / Information and Communication Techno
Information and Communication Technology Lab II (IKT II)
MPO 2015

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory)	none

Learning content:

The laboratory course "Information and Communication Technology Laboratory 2" is meant to provide the hands-on experience for the topics of the lectures offered by the Institute of Telecommunications and High Frequency Techniques. The module allows students to acquire the knowledge concerning the practical application of communication technology methods through labs on RF design, Communication Networks and Communication Technologies.

Learning outcome / Competence:

The students are able to apply theoretical knowledge and to interpret and document measurement results. They get to know modern simulating tools and measuring instruments.

Calculating student workload:

- Präsenzzeit (Versuche): 28 h (4 SWS x 14 Wochen)
- Vor- und Nachbereitung: 28 h (4 h/Woche x 14 Wochen)
- Versuchsprotokolle: 34 h

Arbeitsstunden insgesamt: 90 h

Language of tuition:	Module leader:
English / German	Prof.Dr.-Ing. Armin Dekorsy
	Prof. Dr.-Ing. Martin Schneider, Dr.-Ing. Carsten Bockelmann, Prof. Dr.-Ing. Anna Förster
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 15/16	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Versuchsdurchführungen und Versuchsprotokolle
Pratical course	(Portfolio)

Module courses

Course:	01-15-03-IKT2-P Information and Communication Technology Laboratory 2
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):**
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Module 01-15-03 PMA(a): Projektarbeit (Project)
Project
MPO 2019

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory) • CMM Core Modules (compulsory)	none

Learning content:

The project is an independetn, autonomous, though supervised piece of scientific work. It can be done in a group of students or as the work of one single student. If done in a group, each student's contribution and part be clearly distinguishable. In each case a specific topic is defined by the student together with the supervisor. It is documented in a written project thesis and it is also presented, generally in the seminar of the institute of the supervisor, as an oral presentation.

Learning outcome / Competence:

Within the project, the student learns to perform scientific investigations on a predefined ressearch topic and to document those and the findings in the form of a thesis and to present the results. The student also learns how to work in a group of scientists.

After the project, the student should be prepared for the master thesis.

Calculating student workload:

Language of tuition:	Module leader:
German / English	N.N. Hochschullehrer*innen des FB1
Frequency: WiSe, SoSe	**Duration:** 1 semester[s]
The module is valid since: SoSe 20	**The module is valid until:** -
Credit points / Workload: 18 / 540 hours	**Contact hours:** -

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Project report	Prüfungsleistung

Module 01-15-03 ThsMSc: Masterarbeit
Master Thesis and Colloquium
MPO 2013/2015

Module assignment:	Recommended content-related requirements:
• CIT Core Modules (compulsory) • CMM Core Modules (compulsory)	ref. examination regulations

Learning content:
- Getting familiar with a specific research question and conduct of a literature search on the state of the art
- Development of a working plan
- Application of scientific methods in conducting and evaluating the research work
- Elaboration of own results
- Compilation and discussion of the results
- Presentation and defence of the results in a colloquium

Learning outcome / Competence:

The master's thesis is an autonomous piece of research work conducted under the guidance of a supervisor. The aim is to learn how to plan, to perform and to document scientific work. After the master's thesis, the student should be able to conduct research within industrial surroundings or within a PhD project.

Specifically competences gained in this module:

- Knowledge and experience in structuring a research question and organizing the work thereon
- The state-of-the-art knowledge in the specific research topic
- Skills in independent literature search, screening and evaluation
- Skills in compiling and discussing scientific outcomes in a written report
- Experience in presenting and defending the results

Calculating student workload:
- Work on a specific topic and preparation of a written report (860 h, duration 24 weeks)
- Preparation of presentation and colloquium (40 h)

Total workload: 900 h

Language of tuition:	Module leader:
German / English	N.N. Hochschullehrer*innen des FB01
Frequency: WiSe, SoSe	**Duration:** 1 semester[s]
The module is valid since: SoSe 17	**The module is valid until:** -
Credit points / Workload: 30 / 900 hours	**Contact hours:** -

Module examinations

Type of examination: Masterarbeit	
Examination format: Master Thesis, first examiner	1. Gutachter/in

Type of examination: Kolloquium	
Examination format: Colloquium	Kolloquium

Module 01-15-03 ADS(a): Advanced Digital System Design
Advanced Digital System Design
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	Knowledge in fundamental digital modules and their use in electronic systems. Ability to implement digital modules according to the state of the art.

Learning content:

Multiprocessors

- Taxonomy
  SIMD architectures
  Shared memory vs message passing multiprocessors

Data coherency in multiprocessor systems

- Cache architectures
- Snooping-protocols

Interconnect architectures

- Metrics and topologies
- On-Chip buses
- Networks-on-Chip

A list of references will be provided in the respective courses.

Learning outcome / Competence:
- Relevant skills for the realization of function-specific digital systems, including high-performance processors
- Knowledge in the systematic construction and the design of a digital system
- Ability to design and analyse digital systems with multiple processors

Calculating student workload:

The module comprises lectures and exercises of 4 credit hours:

- Contact hours (lectures and exercises): 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-

Credit points / Workload:	Contact hours:
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-ADS(a)-V Advanced Digital System Design
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 BiM: BioMEMS
BioMEMS
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	none

Learning content:
- Organisation, introduction, basics of microfluidics and BioMEMS
- Flow control: valves and pumps
- Sensors and analysis in BioMEMS devices
- Technology and packaging
- Examples of BioMEMS devices
- Modeling and simulation of microfluidic structures

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

An overview is given of the developments in the area of microfluidic and BioMEMS devices from the early start (where especially silicon integrated valves and pumps were investigated) to the lab-on-a-chip devices of today. The functionality of the sensors and actuators, the technologies applied, and the design of fluidic chips will be discussed. Some basic fluidics aspects will be presented and a practical in which COMSOL is used for the simulation of microfluidic elements is included. A series of examples of currently investigated BioMEMS devices will be shown, e.g. chips for capillary electrophoresis, cytometry and optofluidics.

After this course, students are able to:

- understand the basics of microfluidics,
- understand and explain the functioning of µfluidic devices,
- apply characterization parameters for (elements of) µfluidic and BioMEMS devices,
- understand fabrication technologies for microfluidic and BioMEMS devices.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.

Workload:

- Contact hours: 56 h (4 h/week x 14 weeks)
- Preparation: 28 h (2 h/week x 14 weeks)
- Learning and exercises: 28 h (2 h/week x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-

Credit points / Workload:	Contact hours:
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Portfolio aus schriftlicher Prüfung und Simulationsaufgaben

Module courses

Course:	01-15-03-BiM-V BioMEMS
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vellekoop, Michael, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 CTh1(a): Contol Theory 1
Contol Theory 1
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	none

Learning content:
- Definition and features of state variables
- State space description of linear systems
- Normal forms
- Coordinate transformation
- General solution of a linear state space equation
- Lyapunov stability
- Controllability and observability
- Concept of state space control
- Steady-state accuracy of state space controllers
- Observer
- Controller design by pole placement
- Riccati controller design
- Falb-Wolovitch controller design

References:

- K. Michels: Control Engineering (Script in German and English)

German:

- J. Lunze: Regelungstechnik 2
- O. Föllinger: Regelungstechnik
- H. Unbehauen: Regelungstechnik II

English:

- Norman S. Nise: Control Systems Engineering

Learning outcome / Competence:
- Understanding and handling of state space methodology
- Design of state space controllers with different methods
- Observer design

Calculating student workload:
The module comprises lectures and exercises of 4 credit hours.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Mündliche oder schriftliche Prüfung

Module courses

Course:	01-15-03-CTh1-V Control Theory 1
Frequency:	**Are there parallel courses?**
WiSe, once a year	no
Language:	**University teacher(s):**
English / German	Michels, Kai, Prof. Dr.-Ing.
Teaching method(s):	**Associated module examination:**
Lecture Tutorial	Modulprüfung

Module 01-15-03 InS(a): Integrated Circuits
Integrated Circuits
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	none

Learning content:
- Noise
- gm/Id Method
- Mismatch
- Two-pole opamps (OTA)
- Feedback

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After this course, students are able to:

- describe and characterize noise in electronics circuits,
- apply the gm/Id sizing method to design amplifier circuits for advance CMOS technologies,
- deal with process variations and mismatch,
- understand the frequency behaviour of amplifier circuits,
- understand and size compensation networks,
- use feedback to modify circuit characteristics.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-InS(a)-V Integrated Circuits
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Paul, Steffen, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 Paut(a): Process Automation in Power Grids
Process Automation in Power Grids
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	none

Learning content:
- Basics on process automation operation and control principles
- Sensor and actuators
- Power electronic interfaces
- Programming logic controllers
- Process automation in electrical power systems
- Data and field components
- Network operation principles

Learning outcome / Competence:

This lecture on process automation is an independent one-semester course which will give you a basic knowledge in the wide field of process automation. After the course you will be able to understand the basic structures, operation and control principles of automation processes. You will understand the working principle of the most used sensors, actuators and programming logic controllers. You will be able to program small control tasks. The second part of the course will focus on the process automation in electrical power supply networks. Beside the required field and data components you will get a broad understanding into the network operation principles and tasks of the grid operators.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.
Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Johanna Myrzik
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-Paut(a)-V Process Automation in Power Grids
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Myrzik, Johanna, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 SAMS(a): Sensors and Measurement Systems
Sensors and Measurement Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory)	none

Learning content:

- Basics of Sensors
- Thermal Sensors
- Sensor Technology
- Force and Pressure Sensors
- Inertial Sensors
- Magnetic Sensors
- Flow Sensors

References:

Walter Lang: Sensors and Measurement systems, ISBN-10: 877022028X

Learning outcome / Competence:

After this course, students should be able to:

- name and explain important sensors,
- apply characterization parameters for sensors,
- choose sensors for a given application and apply them,u
- understand micromachining technologies for sensors.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-SAMS(a)-V Sensors and Measurement Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 DDsy: Praktikum Entwurf digitaler Systeme / Laboratory Design of Digital Systems
Laboratory Design of Digital Systems
MPO 2013/2015

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	Mastering algebraic methods of digital technology, Boolean algebra and circuit reduction methods

Learning content:
- Logic syntheses using the Synopsis-Framework
- Layout syntheses using the Cadence-Framework
- Verification of digital systems
- Design-for-Test
- Design of functional blocks, testing of sub-modules and system integration

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Students

- acquire basic knowldege of methods used in CAD-tools for automated design of digital systems

- learn special skills to realize function-specific digital modules and complex circuits

Calculating student workload:
- Contact hours (Labs): 28 h (2 credit hours x 14 Wochen)
- Preparation and follow-up: 28 h (2 h/Woche x 14 Wochen)
- Experimental protocol: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	-

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Studienleistung (Portfolio aus Versuchen und Versuchsprotokollen)

Module 01-15-03 LRT: Praktikum Regelungstechnik / Advanced Control Lab
Advanced Control Lab
MPO 2013/2015

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	Lecture "Control Theory I"

Learning content:
- Crane: Modelling, analysis, and state space control (pole placement method) of a crane
- Inverted pendulum I: Swinging up of an inverted pendulum using different methods
- Inverted pendulum II: Modelling, analysis, and state space control (pole placement method) for the stabilization of an inverted pendulum
- Helicopter: Modelling, analysis, and state space control (Riccati method) of a helicopter model
- Identification and control with an industrial plant control system

References:

- Michels, K.: Script „Control Engineering" (German and English)

- Scripts for each experiment are available in German and English

Learning outcome / Competence:
The students shall get experience with the design and practical application of complex controllers.

Calculating student workload:
- Präsenzzeit (Versuche): 15 h (3 h x 5 Versuche)
- Vorbereitung und Nachbereitung: 75 h

Arbeitsstunden insgesamt: 90 h

Language of tuition:	Module leader:
German / English	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	-

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Portfolio : Successful conduct of experiments and protocols thereof

Module 01-15-03 MMK: Praktikum Mikroelektronik / Laboratory Design of Micro-lelectronics
Laboratory Microelectronics
MPO 2013/2015

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	Lecture "Integrated Circuits"

Learning content:
- Matlab modelling of systems
- Circuit simulation, synthesis, digital layout
- Analog design by gm/id method
- Layout of analog circuits
- Mixed-signal chip design

Practical use of state-of-the-art industrial CAD design tools (Cadence, Synopsys, Mentor); Groups up to 3 students.

Learning outcome / Competence:

Students shall get basic experience of methods for the design of analog and mixed signal integrated circuits using industrial CAD tools starting from a system level specification. Students learn special skills from verification, circuit simulation, synthesis, device sizing down to first steps for layout.

References:

- Michael John Sebastian Smith, Application-Specific Integrated Circuits, Addison-Wesley Publishing Company ISBN 0-201-50022-1
- Charles Stroud, Nur Touba und Laung-Terng Wang, System-On-Chip Test Architectures: Nanometer Design for Testability, ISBN-10: 012373973X
- Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, VLSI Test Principles and Architectures: Design for Testability, ISBN: 978-0-12-370597-6

Calculating student workload:
- Contact hours (lab work): 28 h (2 semester hours x 14 weeks)
- Preparation and follow-up: 28 h (2 h/week x 14 weeks)
- Protocols: 34 h

Arbeitsstunden insgesamt: 90 h

Language of tuition:	Module leader:
German / English	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	-

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Portfolio: Successful conduct of experiments in groups and protocols

Module examinations

Module 01-15-03 Entec: Praktikum Energietechnik / Laboratory Energy Engineering
Laboratory Energy Engineering
MPO 2019

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	Basics in power electronics and drive, basics in power systems

Learning content:

6 experimental simulations with PowerFactory:

- Network calculation
- Asynchronous generators
- Optimal Power Flow, Economical Dispatch
- Decentralized energy resources
- Stability aspects of synchronous generators
- Protection

Learning outcome / Competence:

Students will be able to combine the contents of the energy-related lectures from the Master's programmes in Renewable Energies, Automation Technology and CMM with their own experimental experience.

Calculating student workload:

- Contact hours (experiments): 18 h (3 h x 6 experiments)
- Preparation and follow-up: 48 h (8 h x 6 experiments)
- Protocols and reports: 24 h (4 h x 6 experiments)

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Johanna Myrzik
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 13/14	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	-

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Studienleistung (Experiments, protocols, reports)

Module 01-15-03 MiSP: Praktikum Mikrosystemtechnik (Laboratory Microsystems)
Laboratory Microsystems
MPO 2015 (CMM)

Module assignment:	Recommended content-related requirements:
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	none

Learning content:

• Introduction to microtechnology

• Clean room technology, quality standards in clean room, processing

• Fabrication of a sensor in the clean room

• Characterization of the sensor

Group up to 12 students. Short examination of the preparation before the experiment.

Learning outcome / Competence:

The students

• know how to conduct in a clean room environment;

• can work with process equipment;

• obtain experience with micro technology;

• can characterize a sensor element.

Calculating student workload:

90 hours (contact hours 28 h (block course), preparation 42 h, report 20 h)

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 15/16	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Portfolio: Interviews before and after the experments, protocols

Module 01-93-03 SCL: Laboratory Sensor Characterization
Sensor Characterization Laboratory
MPO v. 08.07.2015

Module assignment:	**Recommended content-related requirements:**
• CMM Core Modules (compulsory) / CMM Options Lab1 + Lab 2	Lecture „Sensors and Measurement Systems"

Learning content:

A thermal sensor for infrared radiation (thermopile) is analyzed. The sensor is exposed to different thermal radiation of varying intensity. Sensitivity, time constant and noise are evaluated.

Groups up to 6 students. Short examination of the preparation before the experiment.

Learning outcome / Competence:

The students shall get experience in using sensors and analyzing sensor data.

Calculating student workload:

Experiments, preparation, follow-up, protocols (90h)

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
once a year as required WiSe or SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
WiSe 18/19	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Portfolio (Versuchsdurchführungen und Versuchsprotokolle)

Module courses

Course:	01-93-03-SCL Laboratory Sensor Characterization
Frequency: once a year as required WiSe or SoSe	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Module 01-15-03 Ant(a): Antennas and Propagation
Antennas and Propagation
MPO v. 04.12.2019

Module assignment:	**Recommended content-related requirements:**
• CIT & CMM Elective Modules	"Theory of electrical engineering - TET" and "Grundlagen der Kommunikations- und Informationstechnik" are strongly recommended.

Learning content:
- Fields and wave in free space based on Maxwell's equations
- Fundamentals of wave propagation
- Fundamentals of antennas
- Hertz Dipole amd magnetic dipole
- Antenna arrays
- Antenna beamforming and beamsteering
- Calculation of aperture antennas
- Microstrip patch antennas
- Presentation and discussion of practical examples

Learning outcome / Competence:

After this course, the students know how

- to describe the fundamentals of wave propagation
- to explain the working principle of antennas;
- to decide which type of antennas suits a certain application at a certain frequency;
- to apply the method of electrodynamic potentials for solving antenna problems;
- to explain and to apply the method.

Calculating student workload:

The module comprises a lecture of 2 credit hours and an exercise of 2 credit hours. Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, self-learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	**Module leader:**
English	Prof. Dr.-Ing. Martin Schneider
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Written examination

Module courses

Course:	01-15-03-Ant(a)-V Antennas and Propagation
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Schneider, Martin, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 ADC erstmalig im SoSe 2021: Advanced Digital Communications
Advanced Digital Communications
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Wireless Communication, Channel Coding

Learning content:
- Information Theory for fading channels and MIMO systems
- Multiple antenna systems
- Factor graphs
- Selected topics

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcome / Competence:

After this course, the students will be able to

- understand basic concepts and information theory limits for MIMO systems;
- understand diversity as well as rate enhancement in MIMO systems;
- understand various detection principles and algorithms for MIMO systems.

Calculating student workload:

The module comprises a lecture with exercises of 2 credit hours:

- Contact hours (lectures and exercises): 28 h (2 h x 14 weeks)
- Preparation, learning and exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Dr.-Ing. Carsten Bockelmann
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 21	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-ADC-V Advanced Digital Communications
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Bockelmann, Carsten, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 ComT(a): Communication Technologies
Communication Technologies
MPO 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	System theory, stochastic systems, basics of communication theory

Learning content:
- Nonlinear digital modulations
- Coherent receivers using carrier recovery and incoherent receivers used for differential modulations
- Decision theory (minimization of probability of error and expected cost)
- Maximum a posteriori (MAP) detection / maximum likelihood (ML) detection
- Linear equalization (MMSE/LS-equalizer, Decision-Feedback equalizer)

Learning outcome / Competence:

After the course, the students will be able to

- understand the fundamentals of nonlinear digital modulation like MSK, GMSK;
- understand the pros-and cons of coherent with decision feedback carrier recovery and incoherent reception for linear and non-linear modulations;
- understand the theory of data decision, to explain the MAP/ML-detection principle and to design related MAP/ML-receivers (e.g. Forney/Viterbi (MLSE) equalizer);
- to understand the method of linear equalization and to design MMSE/LS- and decision feedback equalizer.

Calculating student workload:

The module comprises a lecture, exercises and laboratory exercises of 4 credit hours:

- Contact hours (lectures + exercises): 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-ComT(a)-V Communication Technologies
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 ENC: Emerging Networking Concepts
Emerging Networking Concepts
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

Various emerging research topics in networking, like wireless sensor networks and the Internet of Things, opportunistic and delay-tolerant networks, peer-to-peer networks, device-to-device communications, software defined radios (SDN), cognitive radios, etc.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

The participants will acquire an overview of novel networking concepts and directions. They will be able to name them and to discuss differences between them, to access their advantages and disadvantages and to analyze them.

Calculating student workload:

The module comprises a lecture including exercises of 3 credit hours.

Workload:

- Contact hours (lectures + exercises): 42 h (3 h x 14 weeks)
- Preparation, self-learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 82 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	3 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Combination examination	Successful assessment of homework assignments and a successful project preparation and presentation thereof.

Module courses

Course:	01-15-03-ENC-V Emerging Networking Concepts
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Förster, Anna, Prof. Dr.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 01-15-03 ACC: Advanced Channel Coding
Advanced Channel Coding
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Turbo Codes
- LDPC Codes
- Polar Codes
- Algebraic Coding
- Coded Modulation
- Adaptive Error Control

Learning outcome / Competence:

After this course, the students should be able to:

- understand advanced coding techniques and perform the decoding;
- explain the principle of coded modulation and possible realizations;
- understand the principle of adaptive error control schemes and the difference to forward error correction;
- implement principle encoder and decoder functions in software.

Calculating student workload:

The module comprises a lecture, exercises and laboratory exercises of 4 semester hours:

- Contact hours (L + EC): 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Dr.-Ing. Dirk Wübben
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-ACC-V Advanced Channel Coding
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Wübben, Dirk, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 CIMP(a): Computational Intelligence in Modelling, Prediction and Signal Processing
Computational Intelligence in Modelling, Prediction and Signal Processing
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Introduction to CI & their applications
- Principal constituents of CI
- Fuzzy sets and properties, Fuzzy relation
- Fuzzy logic systems (Mamdani, TS, singleton, relational model)
- Fuzzy inferencing mechanism
- Generation of fuzzy rule (Wang's method)
- Clustering and LSE based rule generation
- Neuro implementation of fuzzy system
- Introduction to ANFIS / neuro-fuzzy network
- Backpropagation, Marquardt training algorithm for neuro-fuzzy network
- Problems in automatic data driven rule generation
- CI Applications in modelling, prediction and intelligent signal processing

Learning outcome / Competence:

After this course, students should be able to:

- understand the importance of computationally intelligent techniques based on fuzzy logic, neural networks, genetic algorithms and fuzzy-neural networks in engineering applications;
- understand the difference between the classical set and fuzzy set, fuzzy set as generalization of crisp set and terms like fuzzy arithmetic, fuzzy logic systems, fuzzification, fuzzy relation, fuzzy-rules, defuzzification, and inferencing mechanism, tuning membership functions etc;
- generate fuzzy rules through learning from examples and clustering method Implement and fine tune the fuzzy logic system using neural networks based technology;
- analyze the transparency, interpretability and accuracy of the fuzzy/ fuzzy-neural model;
- apply fuzzy logic / fuzzy-neural systems in (white box) system modeling, data prediction and linearization of nonlinear sensor characteristic, adaptive filtering purposes etc.

Calculating student workload:

The module comprises a lecture of 2 credit hours including exercises.

Workload:

- Contact hours (lecture + exercise): 28h (2h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34h

Total working hours: 90 h

Language of tuition:	Module leader:
English	PD Dr.-Ing. Ajoy Palit

Frequency:	Duration:
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format:	Written examination and programming exercise
Combination examination	

Module courses

Course:	01-15-03-CIMP(a)-V Computational Intelligence in Modelling, Prediction and Signal Processing
Frequency:	**Are there parallel courses?**
WiSe, once a year	no
Language:	**University teacher(s):**
English	Palit, Ajoy, PD Dr.-Ing.
Teaching method(s):	**Associated module examination:**
Lecture	Kombinationsprüfung
Tutorial	

Module 01-15-03 CTh2(a): Control Theory 2
Control Theory 2
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Control Theory 1

Learning content:
- Zeros of Multi-Input-Multi-Output systems
- Robustness
- Norms
- Design of norm-optimal controllers

Learning outcome / Competence:
- Deeper understanding of linear state space analysis and controller design
- Understanding the idea and the design of norm-optimal controllers

Calculating student workload:

The module comprises lecture and an exercise of 2 credit hours each.

Workload:

- Contact hours (lecture + exercise): 565 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Mündliche oder schriftliche Prüfung

Module courses

Course:	01-15-03-CTh2-V Control Theory 2
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Michels, Kai, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 DIDS(a): Architectures and Design Methodologies of Integrated Digital Systems
Architectures and Design Methodologies of Integrated Digital Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Design tools and abstractions levels
- Physical design: floorplanning and placement; routing and wire estimation; DRC and LVS
- Design-for-Test: scan-based design, boundary scan; BIST
- Test architectures for SoCs
- Test generation and error diagnosis: ATPG; fault simulation

Learning outcome / Competence:

The students will learn the design methodologies, theoretical algorithms, and tools used for the development of microelectronic integrated systems, as well as the strategies regarding their practical implementation with industrial CAD tools. The students will be able to implement a complex microelectronic integrated digital system guaranteeing its correctness and testability.

Calculating student workload:

The module comprises lectures and exercises of 4 credit hours:

- Contact hours: 56 h (4 h x 14 weeks)
- Preparation, learning and exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Prüfungsleistung mdl. oder schrifltich
Announcement at the begin of the semester	

Module courses

Course:	01-15-03-DIDS(a)-V Architectures and Design Methodologies of Integrated Digital Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-04 DHDL(a): Entwurfsverfahren mit Hardwarebeschreibungssprachen / Design Methodologies with Hardware Description Languages
Design Methodologies with Hardware Description Languages
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

Introduction

- IC technologies, design flow and abstraction levels
- Introduction to hardware description languages

Hardware modeling

- Main concept of VHDL
- Discrete event model
- Data types and operators in VHDL

Code structures and structural descriptions

- Structural elements in VHDL
- Hardware partitioning and hierarchies
- Design-for-reuse: generics and generates

RTL level modeling and synthesizable code

- Standard libraries
- Code quality recommendations
- Synthesis and synthesis constraints

Gate level modeling and back-annotation

- VITAL

Behavioral level

- Advanced concepts: files, access types and assertions
- Test benches

EDA Design Flow

Learning outcome / Competence:

The students gain in-depth knowledge of the theoretical basics of methods and tools in hardware design with hardware description languages and strategies for their practical application.

Students can describe, simulate and optimize digital modules in a hardware description language as well as synthesize them for ASICs or FPGAs.

Calculating student workload:

The module comprises lecutres and exercises of 2 credit hours

- Contact hours (L + EC): 28 h (2 h x 14 weeks)
- Preparation, learning and exercises: 32 h
- Preparation for exam: 30 h

Total working hours: 90 h

Language of tuition: German / English	**Module leader:** Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency: SoSe, once a year	**Duration:** 1 semester[s]
The module is valid since: SoSe 20	**The module is valid until:** -
Credit points / Workload: 3 / 90 hours	**Contact hours:** 2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Mündliche oder schriftliche Prüfung

Module courses

Course:	01-15-04-DHDL(a)-V Design Methodologies with Hardware Description Languages
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: German / English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 DS(a): Discrete Systems / Diskrete Systeme
Discrete Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Lectures "Control Theory 1"

Learning content:

- Sampling theorem
- Linear difference equations
- State space description of discrete linear systems
- Stability of discrete systems
- Transformation of a continuous model into a discrete model
- z-transformation
- Controller design for discrete systems
- Adaptive control
- Fuzzy control
- Neural networks

References:

German and English:

- K. Michels: Control Engineering (Script)

English:

- K. Michels: Fuzzy Control
- Norman S. Nise: Control Systems Engineering
- Karl J. Astrom: Adaptive Control
- Ioan Dore Landau: Adaptive Control

Learning outcome / Competence:
This lecture will give insight into discrete control theory, adaptive control, and Fuzzy-Neuro systems.

Calculating student workload:
The module comprises two courses: a lecture and an exercise of 2 credit hours each.
Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English / German	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-

Credit points / Workload:	Contact hours:
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Oral or written examination

Module courses

Course:	01-15-03-DS(a)-V Discrete Systems
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Michels, Kai, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 IoT(a): Internet of Things
Internet of Things
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Basics of Wireless Communication
- Wireless sensor networks and their protocols (6LoWPAN, RPL, CoAP, Zigbee, EnOcean, ISA100, WirelessHART, etc.)
- Wireless LAN standards (IEEE 802.11)
- Vehicle-to-Vehicle networks (V2V)
- Opportunistic networks (Bluetooth, BLE, WiFi ad-hoc, etc.)

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

The Internet of Things (IoT) is an independent one-semester course which will give you a basic understanding of the communication protocols and research directions in the Internet of Things. It will cover a broad spectrum of protocols and concepts, including sensor networks, cyber-physical systems, Industry 4.0, local area networks, vehicular networks and opportunistic communications. After this course, you should be able to:

- name and describe the relevant standards;
- evaluate IoT applications and their communication requirements;
- design and deploy simple IoT applications;
- understand future developments and research challenges in the area of IoT.

Calculating student workload:

The module comprises two courses: a lecture of 2 semester hours and an exercise of 1 semester hour.

Workload:

- Attendance (lecture + exercise): 42 h (3 h x 14 weeks)
- Homework assignments: 42 h (3 h x 14 weeks)
- Project: 96 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	3 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Combination examination	Homework, project, presentation

Module courses

Course:	01-15-03-IoT(a)-V Internet of Things
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Könsgen, Andreas, Dr. Förster, Anna, Prof. Dr.
Teaching method(s): Project Lecture	**Associated module examination:** Kombinationsprüfung

Module 01-15-03 LPWSN(a): Low Power Strategies in Wireless Sensor Networks
Low Power Strategies in Wireless Sensor Networks
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

Introduction of wireless sensor networks from node to network; overview of techniques for nodes' power management including communication protocols, data processing algorithms; introduction of WSN motes' operation.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:
- To understand the principle of wireless sensor networks
- To understand related techniques for power management
- To get familiar with the mote operation and current research in WSNs

Calculating student workload:

The module comprises lectures including exercises of 2 credit hours.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-LPSWN(a)-V Low Power Strategies in Wireless Sensor Networks
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Yu, Wanli, Dr.-Ing.
Teaching method(s): Lecture with tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 MST(a): Microsystems
Microsystems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

- Application areas of Microsystems
- Process integration, processmeasurement, housing techniques, process cost estimation at the example of a pressure sensor
- Microactuators
- Energy in Microsystems
- Sensor networks

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After the course students:

- know important applications of microsystems,
- know how to combine single process steps to full process flows,
- understand process control and measurement techniques,
- have a deepened knowledge in the fields of:

- Microactuators
- Energy in Microsystems
- Sensor networks

Calculating student workload:

The module comprises one course: lectures and exercises of 2 credit hours each.

Workload:

- Contact hours (L + EC): 56h (4 h x 14 weeks)
- Preparation: 56h (4h/week x 14 weeks)
- Preparation for exam: 40 h
- Report preparation: 28

Total working hours: 180

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-MST(a)-V Microsystems
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 MSAE(a): Modeling and Simulation of Sensors, Circuits and Systems in Automotive Electronics
Modeling and Simulation of Sensors, Circuits and Systems in Automotive Electronics
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Electrical circuit theory, Mathematics and C++ / MATLAB programming

Learning content:
- FEM applications in automotive electronics
- Inductive, capacitive, resistive and magnet based automotive sensors modeling
- Stationary, time dependent and frequency domain modeling of automotive sensors
- Monte-Carlo & Worst-Case simulations
- Modeling & simulation of NFC-antenna
- NFC-antenna measurements using VNA & matching circuit design using RF-simulation
- Thermal simulation of automotive electronics using FEM
- Theoretical estimation of sensor signal using transfer function blocks (Laplace transform)
- LTSPICE simulation of sensor circuit
- Reliability calculation

Learning outcome / Competence:
After this course, students should be able to:

- understand the Finite Elements Methods (FEM) and its application to inductive, capacitive, resistive sensors and magnet based Hall automotive sensors modeling etc.;
- understand the stationary, frequency domain and time dependent studies and parametric simulation of aforementioned sensors using COMSOL-Multiphysics/CST-Tool;
- estimate the sensor's signal conditioner output (mV or mA) using transfer function blocks;
- verify the sensors' signal output using circuit simulation (LTSPICE) software;
- undertake processing of sensor's signal (MATLAB/C++ programming) in order to estimate linear & angular positions etc. and linearity test of sensor;
- estimate the tolerance band of sensor's signal conditioner circuit using Monte-Carlo simulation and worst case simulation method for the entire operating temperature range;
- perform magnetic field simulation of a current carrying conductor for the measurement of current using Hall sensor;
- model, design and extract the NFC-antenna parameter for matching circuit design;
- measure the NFC-antenna (S11) parameter with VNA (Smith Chart) and design the suitable matching circuit (for Texas Instruments, NXP & Melexis Transceiver) using RF-simulation;
- simulate & analyze the heat dissipation technique for automotive power electronic system;
- calculate the reliability (FIT/MTTF/MTBF) of automotive electronic circuits and systems.

Calculating student workload:

The module comprises lectures and exercises of 2 semester hours each.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68h

Total working hours: 180 h

Language of tuition:	Module leader:
English	PD Dr.-Ing. Ajoy Palit
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format:	Written examination, simulation exercise
Combination examination	

Module courses

Course:	01-15-03-MSAE-V Modeling and Simulation of Sensors, Circuits and Systems in Automotive Electronics
Frequency:	**Are there parallel courses?**
WiSe, once a year	no
Language:	**University teacher(s):**
English	Palit, Ajoy, PD Dr.-Ing.
Teaching method(s):	**Associated module examination:**
Lecture	Kombinationsprüfung
Tutorial	

Module 01-15-03 NetSimP: Network Simulation Project
Network Simulation Project
MPO 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Network Simulation Theory is strongly recommended, can be taken simultaneously

Learning content:
Design, programming and evaluation of a complete network-related simulation in OMNeT++. Topics vary each semester and can be also proposed by students.

Learning outcome / Competence:
The students learn how to simulate and evaluate complete network simulation scenarios and how to present the simulation results.

Calculating student workload:
- Contact hours: 14 h (1 h x 14 weeks)
- Project work (self-preparation): 66 h
- Presentation: 10 h

Total working hours: 90 h

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	1 hours

Module examinations

Type of examination: Kombinationsprüfung	
Examination format: Combination examination	Report and presentation

Module courses

Course:	01-15-03-NetSimP Network Simulation Project
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** UDUGAMA, Asanga, Dr.-Ing. Förster, Anna, Prof. Dr.
Teaching method(s): Project	**Associated module examination:** Kombinationsprüfung

Module 01-15-03 NLS(a): Nonlinear Systems
Nonlinear Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Lecture „Grundlagen der Regelungstechnik" or equivalent knowledge about basics of control (bode diagrams, nyquist plots, nyquist stability criterion, PID controller design

Learning content:
- Basics and features of nonlinear systems
- Switching functions as transfer elements
- Definition of stability for nonlinear systems
- Direct method of Lyapunov
- Describing function
- Popov criterion, circle criterion, hyperstability
- Sliding-mode control
- Gain Scheduling

A list of references will be provided at the start of the semester.

Learning outcome / Competence:
Based on the lecture „Grundlagen der Regelungstechnik" (Basics of Control Engineering) where only linear systems were discussed, this lecture will concentrate on nonlinear systems with their special features and suitable control solutions. The students shall learn to handle nonlinearities in simple control loops.

Calculating student workload:
The module comprises two courses: a lecture and an exercise of 2 credit hours each.
Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Prüfungsleistung

Module courses

Course:	01-15-03-NLS(a) Nonlinear Systems
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Michels, Kai, Prof. Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 OpT(a): Optimisation Theory
Optimisation Theory
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

The core basics of optimisation theory will be introduced as well as the most popular optimisation strategies.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After successfully concluding this module the students are well acquainted with the most important basics of optimisation theory.

Calculating student workload:

The module comprises a lecture including exercises.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 42 h (3 h x 14 weeks)
- Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	Module leader:
English / German	Dr.-Ing. Dagmar Peters-Drolshagen
Frequency:	**Duration:**
once a year as required WiSe or SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Prüfungsleistung

Module courses

Course:	01-15-03-OpT(a)-V Optimisation Theory
Frequency: once a year as required WiSe or SoSe	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Peters-Drolshagen, Dagmar, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 OtS: Optimisation of Technical Systems
Optimisation of Technical Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

Operation Research Strategies and selected methods of operation research will be introduced, especially those which are suited to support the design of technical systems.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

After successfully concluding this module the students can use the support of Operations Research Strategies successfully within the design phase of technical systems.

Calculating student workload:

The module comprises a lecture inlcuding exercises of 2 credit hours.

Workload:

Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)

Preparation, learning, exercises: 42 h (3 h x 14 weeks)

Preparation for exam: 20 h

Total working hours: 90 h

Language of tuition:	Module leader:
English / German	Dr.-Ing. Dagmar Peters-Drolshagen
Frequency:	**Duration:**
once a year as required WiSe or SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Written examination or oral examination

Module courses

Course:	01-15-03-OtS Optimisation of Technical Systems
Frequency: once a year as required WiSe or SoSe	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Peters-Drolshagen, Dagmar, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 Rob(a): Introduction to Robotics
Introduction to Robotics
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

The module starts with the mathematical preliminaries and the consideration of a manipulator kinematics. In connection to that, direct (forward) as well as inverse kinematics will be investigated. As an important concept for the solution of direct kinematics the so-called Denavit-Hartenberg convention will be introduced. Regarding the solution of inverse kinematics problems both the analytical and numerical solution will be examined. An important topic of the module is also the trajectory planning. The module ends with the consideration of different methods for robot control and basic control strategies for robotic systems.

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Robots are complex mechanical, automatic and informatics systems which are of growing interest not only in industrial robotics but also in other areas such as service robotics, mobile robotics and medical robotics. This module deals with the most important fundamental concepts of the robotics and provides students with the knowledge about the basis of this fascinating and future oriented area. The knowledge gained in lectures, students can apply for solving the practical examples considered in practical exercises.

Calculating student workload:

The module comprises a lecture of 2 semester hours including exercises.

Workload:

- Contact hours (lecture + exercise): 28 h (2 h x 14 weeks)
- Preparation, learning, exercises: 28h (2h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90h

Language of tuition:	Module leader:
English	Dr. Danjela Ristic-Durrant
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Written examination	Prüfungsleistung

Module courses

Course:	01-15-03-Rob(a)-V Introduction to Robotics
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Ristic-Durrant, Danjela, Dr.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 PRobAS: Perception for Robotics and Autonomous Systems
Perception for Robotics and Autonomous Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	Introduction to Robotics

Learning content:

The module is focused on the specific aspects of robotics such as Visual robot control (Visual servoing) and related fields:

- Digital image processing
- Projective transformations
- Camera models
- Stereo vision (epipolar geometry and 3D reconstruction)

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Starting from the basic robot control strategies, this module is focused on the specific (advanced) aspects of robotics such as Visual Robot Control. As such, the module provides students with the knowledge about the basis of this fascinating and future oriented robotics area. Although focused on robotics, the knowledge gained in lectures concerning digital image processing, camera technologies and stereo vision students can apply in a variety of different engineering fields such as biomechanics and car driver assistance systems.

Calculating student workload:

The module comprises two courses: a lecture and an exercise of 2 credit hours each.

Workload:

Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)

Preparation, learning, exercises: 56 h (4 h x 14 weeks)

Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Dr. Danjela Ristic-Durrant
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Prüfungsleistung
Written examination	

Module courses

Course:	01-15-03-PRobAS-V Perception for Robotics and Autonomous Systems
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Ristic-Durrant, Danjela, Dr.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-15-04 STSCN(a): Selected Topics in Sustainable Communication Networks
Selected Topics in Sustainable Communication Networks
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

This module offers the opportunity to learn and discuss various aspects and research fields of sustainability for communication networks, such as:

- Wireless (underground) sensor networks
- Environmental monitoring
- Smart agriculture
- Opportunistic networks
- Energy efficiency in communication networks
- Societal aspects of modern communications

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

The students will learn about various research fields and applications of communication networks, which target the sustainable development goals (SDG) of the United Nations. The students will individually explore a given topic (with the help of research publications or other scientific materials) and prepare a presentation which will be discussed in class with the lecturer and the peers.

Calculating student workload:

The module comprises one course of 2 semester hours.

Workload:

- Attendance (seminar): 28 h (2 h x 14 weeks)
- Preparation, learning and follow-up: 62 h

Total working hours: 90

Language of tuition:	Module leader:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
WiSe, SoSe	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Written report and presentation thereof

Module courses

Course:	01-15-03-STSCN-S Selected Topics in Sustainable Communication Networks*** LV neu ***
Frequency: WiSe, SoSe	**Are there parallel courses?** no
Language: English	**University teacher(s):** Förster, Anna, Prof. Dr.
Teaching method(s): Seminar	**Associated module examination:** Modulprüfung

Module 01-15-03 ScPr: Scientific Practice
Scientific Practice
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Foundations of scientific work and practice
- Reading scientific texts and publications
- Publishing scientific texts
- Writing scientific reports and publications
- Planning, structuring and writing techniques
- Plagiarism and other issues and regulations

Learning outcome / Competence:

This seminar offers the basics of scientific practice. After this, participants will be able to self-responsibly write scientific reports and publications, document experiments and presenting their findings. Furthermore, they will understand the current trends and challenges of the scientific community. The seminar will be based on English texts, discussions will be mixed in English and German and examples will be given from various fields of natural sciences.

Calculating student workload:

The seminar consists of weekly meetings and home readings. The participants are encouraged to identify a concrete publication or report they would like to work on (project report, thesis, scientific publication).

- Preparation: 14 x 3 h = 42 h
- Presence: 14 x 2 h = 28 h
- Report: 20 h

Total: 90 hours

Language of tuition:	Module leader:
English / German	Prof. Dr. Anna Förster
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Portfolio	Successful elaboration and submission of report/ publication/thesis

Module courses

Course:	01-00-00-ScPr-S Scientific Practice
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English / German	**University teacher(s):** Förster, Anna, Prof. Dr.
Teaching method(s): Project	**Associated module examination:** Modulprüfung

Module 01-15-03 SSc(a): Sensor Science
Sensor Science
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Conduct a literature search
- Reading of scientific publications in the field of sensors
- Study specific aspects of sensor science through the found literature
- Write a report on the study
- Oral presentation

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

Students are able to:

- conduct an efficient literature search,
- discriminate between the main and minor aspects of a research topic,
- study and understand the physical and electronic fundamentals of a specific sensor,
- report in word and in writing.

Calculating student workload:

The module comprises two courses: a lecture of 3 semester hours and an exercise of 1 semester hour.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning: 28 h (2 h x 14 weeks)
- Preparation worksheets: 28 h (2 h/week x 14 weeks)
- Preparation of report and presentation thereof: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Announcement at the begin of the semester	Oral presentation of report/paper prepared and examination

Module courses

Course:	01-15-03-SSc(a)-V Sensor Science
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Vellekoop, Michael, Prof. Dr.-Ing.
Teaching method(s): Lecture with tutorial	**Associated module examination:** Modulprüfung

Module 01-95-03 UGer(a): Understanding Germany
Understanding Germany
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Methodic preliminaries
- The " nationbuilding" of Germany, from microstates to a nation 1814-1914
- The path from nationalism to Hitler´s totalitarianism 1918 -1945
- The formation of the democratic Bundesrepublik Deutschland and its problems 1945 – until today

Lectures , group work, discussion. As an option the course might visit the Tank Museum in Munster and the former concentration camp in Bergen-Belsen.

Learning outcome / Competence:
For studying, living and working in Germany it is useful to acquire some basic knowledge about the German culture, the mentality and the political system. So we will take a look at German history and some philosophical and cultural aspects in connection with current political problems and discussions. After that the students will have a deeper insight into the reasoning behind different political positions in Germany.

Calculating student workload:
Seminar, lecutres, readings, homework assignments. 28 contact hours as block courses.

Total working hours: 90h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Seminar paper	Report/essay

Module courses

Course:	01-95-03-UGER(a)-S Understanding Germany
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Lang, Walter, Prof. Dr.-Ing.
Teaching method(s): Seminar	**Associated module examination:**

Module 01-15-03 DMSS(a): Design of Mixed-Signal Systems
Design of Mixed-Signal Systems
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:

Mixed-systems design overview based on the example of 8 bit SAR ADC in 45 nm CMOS

Learning outcome / Competence:

• System-level simulation of mixed signal systems

• In-depth understanding of process and mismatch on the system parameters

Calculating student workload:

The module comprises lectures and exercises of 2 credit hours each.

- Contact hours (L + EC): 56/ h (4 hours x 14 weeks)
- Preparation, learning, exercises: 56h (4hours x 14 weeks)
- Exam preparation: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-DMSS(a)-V Design of Mixed-Signal Systems	
Frequency: WiSe, once a year	**Are there parallel courses?** no	
Language: English	**University teacher(s):** Osipov, Dmitry, Dr.-Ing. Paul, Steffen, Prof. Dr.-Ing.	
Teaching method(s): Lecture with tutorial	**Associated module examination:** Modulprüfung	

Module 01-15-03 NGCN(a): Next Generation Cellular Networks
Next Generation Cellular Networks
MPO v. 04.12.2020

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Mobile communications: History and basics
- LTE/LTE-Advanced (4G) mobile communications
- 5G mobile communications

Learning outcome / Competence:

After the course, the students will:

- be able to understand the 4G and 5G system architecture, its key components and interfaces;
- be able to understand the basic design approaches of 4G and 5G mobile communication systems including RRM methods, MAC protocols, PHY layer baseband technologies;
- be able to understand the 4G and 5G system components such as basestations, mobile handsets and gateways and related interconnections;
- be able to model and evaluate mobile communication system performances;
- have gained insight into the 3GPP standardization and its processes.

Calculating student workload:

The module comprises a (block) lecture of 2 credit hours including exercises:

- Contact hours: 28 h (2 h x 14 weeks)
- Preparation, learning and exercises: 28 h (2 h x 14 weeks)
- Preparation for exam: 34 h

Total working hours: 90 h

Language of tuition:	Module leader:
English / German	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
3 / 90 hours	2 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Prüfungsleistung
Oral	

Module courses

Course:	01-15-03-NGCN(a)-V Next Generation Cellular Networks
Frequency: WiSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Dekorsy, Armin, Prof.Dr.-Ing.
Teaching method(s): Lecture with tutorial	**Associated module examination:** Modulprüfung

Module 01-15-03 SoC(a): Systems on Chip: Architectures and Design Methods
Systems on Chip: Architectures and Design Methods
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Introduction to Systems-on-Chip
- Low-Power techniques for SoCs in nanometric technologies
- On-Chip nano-photonic communication
- 3D technologies

A list of references will be provided at the start of the semester.

Learning outcome / Competence:

The students acquire specialized knowledge about the architectures of modern Systems-on-Chip using heterogeneous technologies (e.g., electrical and photonic) and heterogeneous modules (e.g., processors, accelerators, analog components). They learn the implementation strategies and skills required for the implementation of those Systems-on-Chip in nanometric technologies. They are able to read critically, assimilate, and analyze current research papers regarding systems-on-chip.

Calculating student workload:

The module comprises lectures including exercises of 3 credit hours.

Workload:

- Contact hours (lecture + exercise): 42 h (3 h x 14 weeks)
- Preparation, learning, exercises: 50h
- Preparation of presentation and final work: 88 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	3 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Seminar paper	Prüfungsleistung

Module 01-15-03 DiTe(a): Digital Technology
Digital Technology
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Timing strategies
- Non-programmable hardware modules
- Programmable hardware modules
- Selected algregraic and Boolean operations
- Introduction to digital coding

Learning outcome / Competence:
none

Calculating student workload:

The module comprises lecture and exercises of 2 credit hours each.

Workload:

- Contact hours (lecture + exercise): 56 h (4 h x 14 weeks)
- Preparation, learning, exercises: 56 h (4 h x 14 weeks)
- Preparation for exam: 68 h

Total working hours: 180 h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
WiSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format:	Prüfungsleistung
Written examination	

Module courses

Course:		01-15-03-DiTe(a)-V Digital Technology
Frequency: WiSe, once a year	**Are there parallel courses?** no	
Language: English	**University teacher(s):** Garcia-Ortiz, Alberto, Prof. Dr.-Ing.	
Teaching method(s): Lecture with tutorial	**Associated module examination:** Modulprüfung	

Module 01-15-03 AtD(a): Analog to digital Converters
Analog to digital Converters
MPO v. 04.12.2019

Module assignment:	Recommended content-related requirements:
• CIT & CMM Elective Modules	none

Learning content:
- Theory of analog digital conversion
- Static and dynamic errors
- Sample and hold circuits
- Realisations of ADCs, parallel structures, multistage converters, SAR ADCs, delta sigma ADCs

Learning outcome / Competence:

After this course, the students

- know the basic modules of ADCs;
- understand errors in ADCs;
- know how to select the appropriate structure for a given specification.

Calculating student workload:

The module comprises lectures and exercises of 2 credit hours each

- Contact hours: 56 h (4 SWH x 14 weeks)
- Preparation, learning and exercises: : 56 h (4 h/week x 14 weeks)
- Preparation for exam: 68

Total working hours: 180h

Language of tuition:	Module leader:
English	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
SoSe, once a year	1 semester[s]
The module is valid since:	**The module is valid until:**
SoSe 20	-
Credit points / Workload:	**Contact hours:**
6 / 180 hours	4 hours

Module examinations

Type of examination: Modulprüfung	
Examination format: Oral	Prüfungsleistung

Module courses

Course:	01-15-03-AtD(a)-V Analog to Digital Converters
Frequency: SoSe, once a year	**Are there parallel courses?** no
Language: English	**University teacher(s):** Osipov, Dmitry, Dr.-Ing.
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung