Module Handbook
Master Program
Computer Engineering

Faculty for Electrical Engineering, Computer Science and Mathematics
University of Paderborn

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Contents

Chapter 1

Preliminaries

This module handbook describes the modules and courses of the master program Computer Engineering with their goals, contents and relationships. For students, the module handbook shall provide useful and binding information to support them in planning their studies. For teachers and the interested reader the handbook provides an in-depth view into the structure and organization of the study program.

The following paragraphs present a list of abbreviations, the curriculum of the Master program Computer Engineering and an exemplary schedule of courses, comment on the training of soft skills and show the schemes for describing modules and courses used in this handbook. Details and regulations regarding examination modalities and grading rules are provided in the document „Prüfungsordnung für den Master-Studiengang Computer Engineering“.

1.1 List of Abbreviations

LP	Credit points according to ECTS
SWS	Weekly presence hours for the course
2V	Lecture with 2 SWS
2Ü	Exercise with 2 SWS
2P	Project with 2 SWS
2S	Seminar with 2 SWS
WS	Winter semester
SS	Summer semester

1.2 Curriculum & Schedule

Figure 1.1 shows the curriculum and an exemplary schedule of modules for the master program Computer Engineering. The master program comprises two mandatory modules (12 LP each), elective modules (42 LP), a module Scientific Workstyle (6 LP), the module Project Group (18 LP) and the master theses (30 LP). For the elective modules, the program defines six focus areas for which this handbook lists corresponding module catalogs. Each student selects one out of these focus areas and completes modules totalling 22-26 LP in this focus area. Another set of modules totalling 16-20 LP can be selected from any of the focus areas. The module Scientific Workstyle contains a seminar with 4 LP and an elective, ungraded course in languages, writing and presentation techniques with 2 LP.

1.3 Training of Soft Skills

The master program Computer Engineering includes a number of courses in which training of soft skills is an integral component:

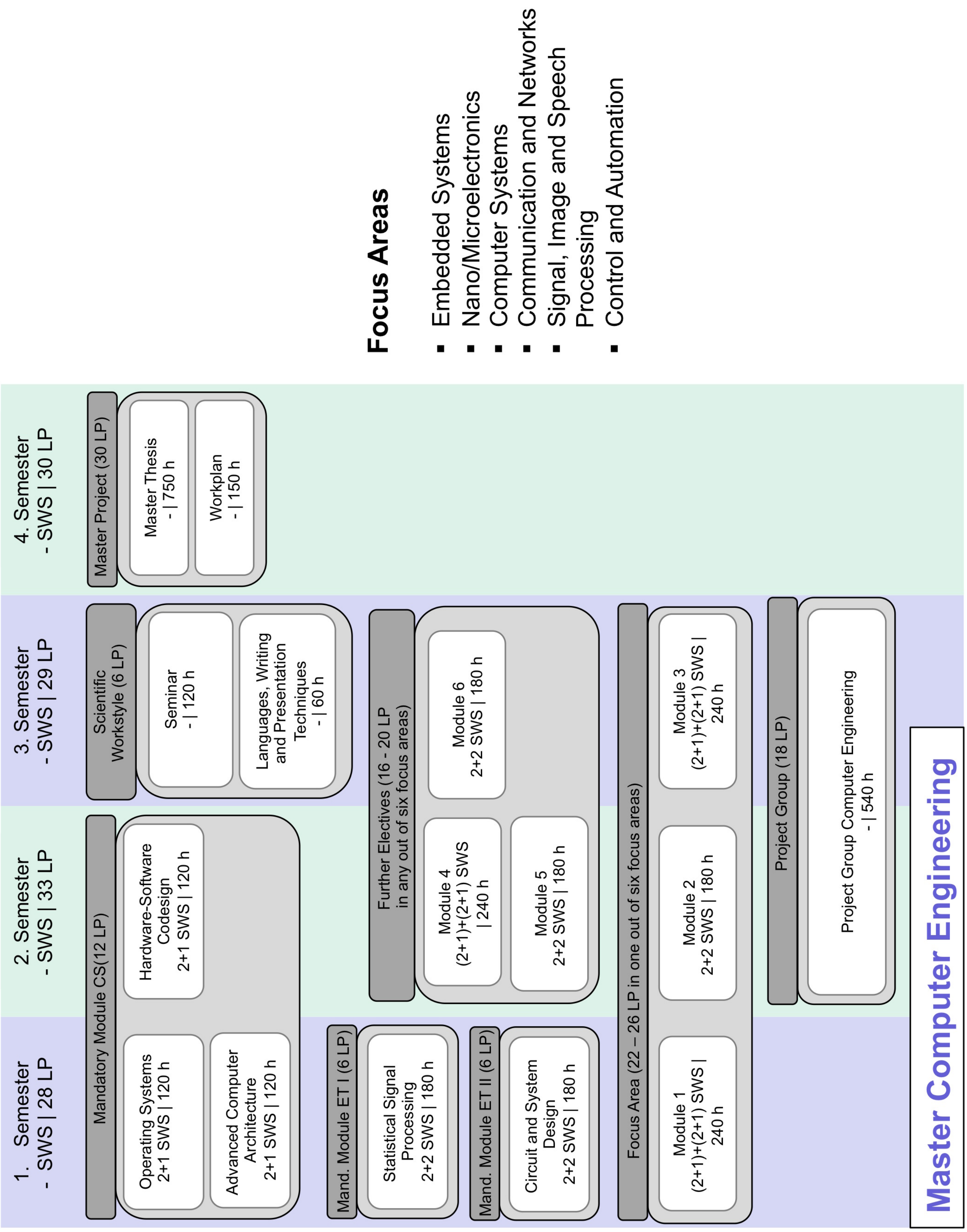

Figure 1.1: Curriculum and exemplary schedule of courses for the master program Computer Engineering

- project group Computer Engineering (module Project Group)
- seminar (module Scientific Workstyle)
- an elective course in languages, writing and presentation techniques (module Scientific Workstyle)
- master thesis including the presentation of the thesis and the work schedule (module Master Thesis)

Besides providing training in a joined-up scientific-technical way of thinking, these courses greatly strengthen communication, presentation, moderation and self-reflection skills. The amount of credit points devoted to soft skills training totals to 54 LP. Actually, the number of courses including soft skills training is much higher, since exercise sessions often require and train communication skills, the ability to work in a team and competences in using modern information technology. This also applies to many of the lectures when using novel forms of teaching.

1.4 Scheme for Module Descriptions

The module descriptions are consistently structured according to the following scheme:

Module name	<Name of the module>
Courses	<List of courses in the module (incl. page references)>
Module type	<Mandatory or elective module>
Module advisor	<Responsible person for the module>
Language	<Teaching language for the module>
Implementation method	<Lectures, exercises, labs, seminars>
Contact hours (per week & semester)	<Total weekly contact hours for the module >
Credits ECTS	<Total credit points for the module>
Work load	<Total workload (ECTS), split into contact times and times for self-study. One weekly contact hour amounts to 60 minutes.>
Learning objectives	<Short summary of the main learning objectives of the module>
Assessment modalities	<Written exam, oral exam or other examination modalities>
Remarks	

1.5 Scheme for Module Descriptions

The course descriptions are consistently structured according to the following scheme:

Course	<Title of the course>
Coordination	<Lecturer>
Teaching Unit	<Institute offering the course>
Language	<Teaching language>
Type	<Contact times in weekly hours and organisational form (lecture, exerices, seminar, lab, project)>
Work load	<Total workload (ECTS), split into contact times and times for self-study.>
Course homepage	<Web page of the course, the lecturer or the institute>
Intended semester	<Winter or summer semester>
Modules using this course	<Modules containing this course (incl. page references)>

Short description

<Short summary of the contents and learning objectives>
Content
<Main contents of the course>
Learning objectives, competences
<Gained knowledge, skills and competencies>
Implementation
<Social forms and didactical-methodical practices used in the course>
Recommended knowledge
<The prerequisites are recommendations rather than requirements to be checked>
Assessment modalitites
<Assessment forms (e.g., written exam, oral exam, presentation, homework, project, lab attestation)>
Teaching material, literature
Comments

Chapter 2

Focus areas

2.1 Communication and Networks

Focus area Communication and Networks comprises the following modules:
- Clouds, Grids, and HPC (S. 36)
- Mobile Networks (S. 37)
- Networking Techniques (S. 38)
- Networking Theory (S. 39)
- Optical Communication A (S. 40)
- Optical Communication B (S. 41)
- Optical Communication C (S. 42)
- Optimale und adaptive Filter (S. 43)
- Security (S. 44)
- Wireless Communications (S. 45)

2.2 Computer Systems

Focus area Computer Systems comprises the following modules:
- Clouds, Grids, and HPC (S. 36)
- Computer Architecture (S. 47)
- Hardware Fault Tolerance (S. 48)
- Large-scale IT systems (S. 49)
- Security (S. 44)

2.3 Control and Automation

Focus area Control and Automation comprises the following modules:
- Advanced Control (S. 51)
- Advanced Topics in Robotics (S. 50)
- Biomedizinische Messtechnik (S. 52)
- Digitale Reglungen (S. 53)
- Dynamic Programming and Stochastic Control (S. 54)
- Flachheitsbasierte Regelungen (S. 55)
- Geregelte Drehstromantriebe (S. 56)
- Optische Messverfahren (S. 57)
- Regelungstechnik B (S. 58)
- Regelungstheorie - Nichtlineare Regelungen (S. 59)

- Robotics (S. 60)
- Systemtheorie - Nichtlineare Systeme (S. 82)
- Ultraschall-Messtechnik (S. 61)
- Umweltmesstechnik (S. 62)

2.4 Embedded Systems

Focus area Embedded Systems comprises the following modules:
- Algorithms and Tools for Test and Diagnosis of Systems on Chip (S. 63)
- Computer Architecture (S. 47)
- Real-time/Embedded Systems (S. 65)
- SW-Engineering for Embedded Systems (S. 66)
- Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik (S. 64)
- Test hochintegrierter Schaltungen (S. 67)

2.5 Nano/Microelectronics

Focus area Nano/Microelectronics comprises the following modules:
- Algorithms and Tools for Test and Diagnosis of Systems on Chip (S. 63)
- Einführung in die Hochfrequenztechnik I (S. 68)
- Halbleiterprozesstechnik (S. 69)
- High Frequency Engineering (S. 70)
- Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik (S. 64)
- Technologie hochintegrierter Schaltungen (S. 71)
- Test hochintegrierter Schaltungen (S. 67)

2.6 Signal, Image, and Speech Processing

Focus area Signal, Image, and Speech Processing comprises the following modules:
- Advanced System Theory (S. 72)
- Algorithmen der Spracherkennung (S. 73)
- Digital Image Processing I (S. 74)
- Digital Image Processing II (S. 75)
- Digitale Sprachsignalverarbeitung (S. 76)
- Kognitive Sensorsysteme (S. 77)
- Messstochastik (S. 78)
- Modellbildung, Identifikation und Simulation (S. 79)
- Optimale Systeme (S. 80)
- Optimale und adaptive Filter (S. 43)
- Statistische Lernverfahren und Mustererkennung (S. 81)
- Systemtheorie - Nichtlineare Systeme (S. 82)
- Technische kognitive System (S. 83)
- Topics in Pattern Recognition and Machine Learning (S. 84)
- Topics in Signal Processing (S. 85)
- Verarbeitung statistischer Signale (S. 86)
- Videotechnik (S. 87)
- Wireless Communications (S. 45)

Chapter 3

Module tables

3.1 Mandatory module: Computer Science

Module name	Computer Science
Courses	• Advanced Computer Architecture (S. 14) • Hardware/Software Codesign (S. 16) • Operating Systems (S. 18)
Module type	Mandatory module
Module advisor	Prof. Dr. Marco Platzner
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	6 SWS VL, 3 SWS UE
Credits ECTS	12
Work load	• 90 h contact hours lectures • 45 h contact hours exercises • 225 h self-study **360 h total workload**
Learning objectives	After successful completion of this module, students are able to understand principles and methods used at the architecture and operating system levels of modern computer systems. They can analyze and evaluate such systems. Moreover, students are able to name and apply modeling and optimization techniques for the integrated design of hardware/software systems.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.1.1 Course of mandatory module Computer Science: Advanced Computer Architecture

Course	Advanced Computer Architecture
Coordination	Prof. Dr. Marco Platzner
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/computer-engineering-group/`
Intended semester	Summer term
Modules using this course	Informatik (S. 13)
Short description	
The course „Advanced Computer Architecture“ teaches concepts and methods used in modern processor architecture to exploit the available parallelism at the levels of instructions, data and threads.	
Content	
The course covers the following topics: • Fundamentals of computer architectures • Memory hierarchy design • Instruction-level parallelism • Data-level parallelism: Vector, SIMD and GPU architectures • Thread-level parallelism	
Learning objectives, competences	
After attending the course, the students • are able to explain principles of modern memory hierachies, • to analyze different levels of parallelism, • to assess the suitability of different architectural concepts and thus • to evaluate modern developments in computer architecture.	
Implementation	
Lecture with beamer and blackboard; interactive exercises; Analysis of case studies.	
Recommended knowledge	
Basic knowledge in computer architecture	
Assessment modalitites	
Mündliche Prüfung	
Teaching Material, literature	
• Lecture slides, exercise sheets • Selected papers • Hennessey, Patterson: Computer Architecture: A Quantitative Approach (5th edition), Morgan Kaufmann, 2012.	

Comments
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3.1.2 Course of mandatory module Computer Science: Hardware/Software Codesign

Course	Hardware/Software Codesign
Coordination	Jun.-Prof. Dr. Christian Plessl
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://homepages.uni-paderborn.de/plessl/`
Intended semester	Summer term
Modules using this course	Informatik (S. 13)

Short description

Hardware/Software Codesign denotes the integrated and automated design of hardware and software in computer systems. The course "Hardware/Software Codesign" teaches concepts and methods used in computer aided design tools for design space exploration, design optimization and compilation for special-purpose computer systems.

Content

- Target architectures
- Introduction to compilers
- System design
- Architecture synthesis
- System partitioning
- Design space exploration

Learning objectives, competences

Participants in this course can name the objectives and challenges in the design of special-purpose computer systems. They can characterize target architectures for implementing HW/SW systems and assess the suitability of a particular target architecture for a given application. They can describe the structure of a compiler, understand and apply basic blocks and control flow graphs, and discuss optimization and code generation methods. They can demonstrate how programs are translated to hardware using high-level synthesis methods. They understand integer linear programming and can apply it to synthesis, scheduling and software performance estimation problems.

Implementation

Lecture with slides and blackboard; homework assignments; programming assignments

Recommended knowledge

Basic knowledge in computer architecture

Assessment modalitites

Oral exam

Teaching Material, literature

Slides; selected research papers; text books (complementary);

Comments
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3.1.3 Course of mandatory module Computer Science: Operating Systems

Course	Operating Systems
Coordination	Prof. Dr. Falko Dressler
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`htto://http://www.ccs-labs.org/`
Intended semester	Winter term
Modules using this course	Informatik (S. 13)
Short description	
Text folgt noch	
Content	
Text folgt noch	
Learning objectives, competences	
Text folgt noch	
Implementation	
Text folgt noch	
Recommended knowledge	
Text folgt noch	
Assessment modalitites	
Text folgt noch	
Teaching Material, literature	
Text folgt noch	
Comments	
Text folgt noch	

3.2 Mandatory module: Electrical Engineering II

Module name	Electrical Engineering II
Courses	• Statistical Signal Processing (S. 20) • Verarbeitung statistischer Signale (S. 21)
Module type	Mandatory module
Module advisor	Prof. Peter Schreier, PhD
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The compulsory modules “Electrical Engineering I and II” aim at a deeper understanding of the necessary background in electrical engineering. After completing the module ‘Electrical Engineering I” they are able to explain and apply the most important methods and principals of statistical processing.
Assessment modalities	One oral or one written exam determines module grade
Remarks	Statistical Signal Processing can be replaced by Verarbeitung statistischer Signale (2+2).

3.2.1 Course of mandatory module Electrical Engineering II: Statistical Signal Processing

Course	Statistical Signal Processing
Coordination	Prof. Peter Schreier, PhD
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sst.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Elektrotechnik I (S. 19)

Short description

Statistical signal processing comprises the techniques that engineers and statisticians use to draw inference from imperfect and incomplete measurements. This course covers a selection of topics from the major domains of detection, estimation, and time series analysis.

Content

Topics that may be covered in this course include correlation analysis, linear minimum mean-squared error estimation, performance bounds for parameter estimation, Neyman-Pearson detectors, wide-sense stationary, nonstationary and cyclostationary time series, and complex-valued random signals.

Learning objectives, competences

After attending this course, students will be familiar with the basic principles of statistical signal processing. They will understand how to apply statistical signal processing techniques to relevant fields in electrical engineering (such as communications). Students will develop confidence in their ability to solve mathematical problems of analysis and design. They will be able to apply the principles they have learned in this course to other areas.

Implementation

Lectures and exercises (including some computer simulations)

Recommended knowledge

Undergraduate courses in signal processing and probability

Assessment modalitites

Oral exam

Teaching Material, literature

Handouts and tutorial questions, literature references will be given in the first lecture.

Comments

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3.2.2 Course of mandatory module Electrical Engineering II: Verarbeitung statistischer Signale

Course	Verarbeitung statistischer Signale
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Winter term
Modules using this course	Elektrotechnik I (S. 19), Verarbeitung statistischer Signale (S. 86)
Short description	
Statistics in many fields of computer engineering. Estimators and detectors. Statistical time series. Statistical significance.	
Content	
Randomness, random variables, maximum likelihood estimators, Cramer Rao bound, confidence intervals, Neyman Pearson rule, hypothesis testing, stochastic processes, Markov chains, Wiener filter.	
Learning objectives, competences	
Students understand how to apply stochastic techniques to computer engineering problems.	
Implementation	
Lecture with blackboard, homework assignments, practical work with matlab.	
Recommended knowledge	
Basics in stochastic signal description.	
Assessment modalitites	
Written or oral exam	
Teaching Material, literature	
Script and textbooks. • N. Henze, Stochastik für Einsteiger, 8. Auflage, Vieweg-Teubner Verlag, 2010 • E. Hänsler, Statistische Signale — Grundlagen und Anwendungen, 3. Auflagen, Springer, 2001 • S. M. Kay, Fundamentals of Statistical Signal Processing — Estimation Theory, Prentice Hall, 1993 • J. L. Mela, D. L. Cohn, Decision and Estimation Theory, McGraw-Hill, Kogakusha, 1987. • A. Papoulis, Probability, Random Variables, and Stochastic Processes, 2. Ausgabe, McGraw-Hill, New York, 1984.	

Comments
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3.3 Mandatory module: Electrical Engineering II

Module name	Electrical Engineering II
Courses	• Circuit and System Design (S. 24)
Module type	Mandatory module
Module advisor	Prof. Dr.-Ing. Christoph Scheytt
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The compulsory modules “Electrical Engineering I and II” aim at a deeper understanding of the necessary background in electrical engineering. After completing the module “Electrical Engineering II” they have acquired a deeper knowledge in circuit and system design. They have learned to model, to analyze, and to design both analog and digital components.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.3.1 Course of mandatory module Electrical Engineering II: Circuit and System Design

Course	Circuit and System Design
Coordination	Prof. Dr.-Ing. Christoph Scheytt
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www.hni.uni-paderborn.de/sct/`
Intended semester	Summer term
Modules using this course	Elektrotechnik II (S. 23)
Short description	
The lecture gives an introduction to analysis and design of analog and digital circuits and systems.	
Content	
• Analysis methods for analog systems • Analysis methods for digital systems • Elementary analog and digital circuits • Modeling and numerical simulation of analog and digital circuits and systems • Typical components and subsystems • Application examples	
Learning objectives, competences	
The students will be able to • describe appropriate methods for analysis and design of analog systems • describe appropriate methods for analysis and design of digital systems • assess the limitations of the different methods • understand and calculate the behaviour of simple analog and digital circuits • use a numeric simulation tool for electronic systems and circuit simulation	
Implementation	
• Powerpoint and Whiteboard • Mathematical exercises and design exercises with modern IC design software	
Recommended knowledge	
It builds on basic knowledge of electronic devices and system theory.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
See course webspage.	
Comments	

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3.4 Mandatory module: Project group

Module name	Project group
Courses	• Projektgruppe (S. 28)
Module type	Mandatory module
Module advisor	Prof. Dr. Holger Karl
Language	German & English
Implementation method	A project group consists of a group of student (typically 8–12) who jointly work on a topic from current research; the group lasts for one calendar year. As a team, the participants elaborate a problem, find solutions, realize them and present their results in regular meetings. Additionally, a project group comprises a seminar phase where team members educate themselves to an expert-level knowledge for relevant areas and provide this knowledge to the group. New projet groups start each semester. Their topics are presented publicly at the end of the previous semester and students can register with a group in which they are interested.
Contact hours (per week & semester)	Not applicable to project groups
Credits ECTS	18
Work load	540 h, varying over the year between independent work, seminars, group meetings.
Learning objectives	Owing to the high level of the project work that happens close to the forefront of research, and owing to the need to work as a team to achieve the project goals, the project group module is uniquely suited to foster competences in technical domains als well as methodic and soft skill competences. Competences in the given technical domain are naturally closely tied to the chosen topic for the project group and can hence not be described in a uniform fashion. Methodically, students lean • how to structure a complex problem setting into smaller, manageable tasks, • to identify missing knowledge and skills and how to obtain them independently, possibly even across disciplines, • to specify complex problems, • to develop a suitable project plan, to control it and adapt it if needs be, • to validate their results their specifications, to evaluate them and critically judge them, • to keep thinking on the basis of their results and to develop new questions and development options.

	With respect to soft skills, students learn • to communicate effectively and efficiently within a group and with customers (possibly across cultural boundaries), • to organize a team, to optimally exploit difference competences of team members, • to deal with unavoidable problems during a project execution, • to structure and present their results.
Assessment modalities	Project work
Remarks	—

3.4.1 Course of mandatory module Project group: Projektgruppe

Course	Project group
Coordination	Dozenten der Elektrotechnik und Informatik
Teaching Unit	Department of Electrical Engineering and Information Technology, Department of Computer Science
Language	German & English
Type	Not applicable to project groups
Work load	540 h, varying over the year between independent work, seminars, group meetings.
Course homepage	`http://ei.upb.de/,http://www.upb.de/cs/`
Intended semester	Project groups start both in the summer and winter term.
Modules using this course	Projektgruppe (S. 26)
Short description	
Compare module description (p. 26).	
Content	
Compare module description (p. 26).	
Learning objectives, competences	
Compare module description (p. 26).	
Implementation	
Self-organised team work, based on a given task from up-to-date research. The group is assisted topic-wise and methodically by the supervisors. A seminar is integrated to provide technical expertise needed to achieve the project goals. Regular meetings of the group with the supervisors to present intermediate results, work plans, etc; nevertheless, the groups are encouraged to work self-organized as much as possible.	
Recommended knowledge	
Secure knowledge of Bachelor-level topics; depending on the group topic, a small amount of Master-level classes might be required as well.	
Assessment modalitites	
Compare module description (p. 26).	
Teaching Material, literature	
Will be published on the course website.	
Comments	
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3.5 Mandatory module: Scientific work style

Module name	Scientific work style
Courses	• Seminar (S. 30) • Sprachen, Schreib- und Präsentationstechnik (S. 32)
Module type	Mandatory module
Module advisor	Jun.-Prof. Dr.-Ing. Katrin Temmen
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	Depends on the chosen language class, technical writing class, ... The seminar has 2 SWS.
Credits ECTS	6
Work load	180 h
Learning objectives	The goal of this module is to enable students (a) to autonomously familiarize themselves with complex technical and scientific material and (b) to effectively and efficiently communicate such material in speech and writing. To this end, the module comprises a seminar on scientific topics from computer engineering and an elective class on language, technical writing, presentation techniques, etc.
Assessment modalities	Only the seminar is relevant for the grade of this module; for the chosen language class, technical writing class, . . . , a certificate of participation suffices.
Remarks	—

3.5.1 Course of mandatory module Scientific work style: Seminar

Course	Seminar
Coordination	Dozenten der Elektrotechnik und Informatik
Teaching Unit	Department of Electrical Engineering and Information Technology, Department of Computer Science
Language	German & English
Type	2 SWS Seminar
Work load	• 30 h Seminar • 90 h self-study **120 h total workload**
Course homepage	`http://ei.upb.de/,http://www.upb.de/cs/`
Intended semester	Winter term and Summer term
Modules using this course	Wissenschaftliches Arbeiten (S. 29)

Short description

Goal of a seminar is in-depth, autonomous work in a complex, scientific topic, the necessary literature research, and the presentation of the results in speech and writing. They also serve to familiarize students with the main mechanisms used by the scientific community (conferences, peer reviews, . . .). Seminars are offered by all lecturers; topics are taken from their research areas and change from semester to semester.

Content

The scientific topics of seminars are highly volatile. Structural aspects include:
- Literature research and selection of publications (typically, a number of closely related publications)
- Structuring the topic
- Preparing a draft seminar report
- Mutual reviews of the drafts (acting as a "technical program committee")
- Finalizing the drafts based on review feedback
- Presenting the results in a presentation

Learning objectives, competences

Students are able to
- find relevant literature, assess its suitability for a topic, reject irrelevant material, make a selection and justify it,
- from selected literature, identify salient points, compare different sources with each other, contrast their findings, identify and explain commonalities or contradictions,
- present identified material in understandable form in speech and writing, draw conclusions from such material and justify these conclusions,
- pinpoint strengths and weaknesses in written or oral presentations, classify it, justify these decisions and provide constructive criticism.

Implementation
Seminars are based on a list of topics, from which participants can choose. A seminar encompasses meetings where topic assignment, literature research, selecting relevant literature, presentation techniques, technical writing etc. are discussed. In close interaction between participants and advisors, a couple of milestones are undertaken to develop a seminare writeup and a presentation, which is later on presented to the group and discussed.
Recommended knowledge
None in general; depending on the particular topic, some prior contact with the area can be helpful (e.g., in Bachelor classes).
Assessment modalitites
The grade is determined by the writeup, the presentation, and the participation in seminare discussions.
Teaching Material, literature
Current scientific publications.
Comments
—

3.5.2 Course of mandatory module Scientific work style: Sprachen, Schreib- und Präsentationstechnik

Course	Language course, scientific writing
Coordination	Dozenten der Universität Paderborn
Teaching Unit	University of Paderborn
Language	German & English
Type	Depends on chosen course
Work load	60 h
Course homepage	`http://www.uni-paderborn.de/`
Intended semester	Depends on chosen course
Modules using this course	Wissenschaftliches Arbeiten (S. 29)
Short description	
Students are free to choose, depending on their interests, prior knowledge, and talents, a course on language, scientific writing or presentation skills. The choice can be made from the courses offered by the University of Paderborn.	
Content	
A course on language, scientific writing or presentation.	
Learning objectives, competences	
Depending on the chosen course, the student's language, writing, or media competences are enhanced.	
Implementation	
Depends on chosen course	
Recommended knowledge	
None	
Assessment modalitites	
Exam depends on the chosen course. There is no relevant grade (pass/fail).	
Teaching Material, literature	
Depends on chosen course.	
Comments	
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3.6 Mandatory module: Final project

Module name	Final project
Courses	• Arbeitsplan (S. 34) • Master-Arbeit (S. 35)
Module type	Mandatory module
Module advisor	Prof. Dr.-Ing. Sybille Hellebrand
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	Does not apply for final project.
Credits ECTS	30
Work load	• 150 h Creating work plan • 750 h Master thesis **900 h total work load**
Learning objectives	In their final project, students work on and solve a problem using scientific methods in a given amount of time. They should use knowledge and competences acquired during their studies, in particular, how to plan and structure a project into individual steps and how to present results of their work in written and oral form.
Assessment modalities	Final thesis
Remarks	Arbeitsplan nicht benotet; Zulassung zur Masterarbeit erst nach erfolgreichem Abschluss von Modulen im Umfang von 45 LP; Masterarbeit muss aus Vertiefungsgebiet sein.

3.6.1 Course of mandatory module Final project: Arbeitsplan

Course	Work plan
Coordination	Dozenten der Elektrotechnik und Informatik
Teaching Unit	Department of Electrical Engineering and Information Technology, Department of Computer Science
Language	German & English
Type	Work plan for final project
Work load	150 h Creating work plan
Course homepage	`http://ei.upb.de/,http://www.upb.de/cs/`
Intended semester	Permanently on offer
Modules using this course	Abschlussarbeit (S. 33)
Short description	
Based on a topic defined jointly with the advisor of the thesis, the student familiarizes herself/himself with the area by doing a literature search and surveying existing results and approaches. On this basis, a work plan has to be prepared that documents the intended results and milestones for the thesis.	
Content	
Structuring the actual thesis.	
Learning objectives, competences	
Structuring a project of significant size; preparing the Master thesis.	
Implementation	
Direct contact with advisor.	
Recommended knowledge	
Depending on chosen topic.	
Assessment modalitites	
Work plan does not earn a grade.	
Teaching Material, literature	
Depending on topic and as recommended by advisor	
Comments	
—	

3.6.2 Course of mandatory module Final project: Master-Arbeit

Course	Master thesis
Coordination	Dozenten der Elektrotechnik und Informatik
Teaching Unit	Department of Electrical Engineering and Information Technology, Department of Computer Science
Language	German & English
Type	Final thesis
Work load	750 h Master thesis work
Course homepage	`http://ei.upb.de/,http://www.upb.de/cs/`
Intended semester	Permanently on offer
Modules using this course	Abschlussarbeit (S. 33)
Short description	
In a Master thesis, a problem is solved using scientific methods within a given time. The thesis' topic comes from the scientific context of the departments or leverage the multitude of collaborations with industry. Apart from practical relevance, a Master thesis ensures the ability to work scientifically and based on solid methods.	
Content	
Concrete topics for Master theses are continuously published on the web pages of the Department of Computer Science and the Department of Electrical Engineering and Information Technology. Topics vary and can be oriented towards methods or applications.	
Learning objectives, competences	
Students are able to • to structure and solve a problem using scientific methods within a given deadline, • use the skills and knowledge acquired during their studies to this end.	
Implementation	
Independent work, supported by individual tutoring.	
Recommended knowledge	
Depending on chosen topic.	
Assessment modalitites	
The grade of the master thesis is determined by: • Intermediate presentation • Final presentation with discussion • Written Master thesis	
Teaching Material, literature	
Depending on topic and as recommended by advisor	
Comments	
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3.7 Module: Clouds, Grids, and HPC

Module name	Clouds, Grids, and HPC
Courses	• Architektur paralleler Rechnersysteme (S. 98) • Cloud Computing (S. 100) • Empiric Performance Evaluation (S. 120) • Fortgeschrittene verteilte Algorithmen und Datenstrukturen (S. 123) • Future Internet (S. 124) • Reconfigurable Computing (S. 157) • Routing and Data Management in Networks (S. 163)
Module type	Elective module
Module advisor	N.N.
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module covers cloud and grid computing as well as high performance computing (HPC). The lectures elective in this module span a relatively wide range from theoretic foundations over system design and data centre structure to hardware concepts for HPC. Concrete learning objectives hence highly depended on the chosen lectures. It is highly recommended to choose the lecture Cloud Computing.
Assessment modalities	One oral module exam
Remarks	—

3.8 Module: Mobile Networks

Module name	Mobile Networks
Courses	• Empiric Performance Evaluation (S. 120) • Future Internet (S. 124) • Mobile Communications (S. 141)
Module type	Elective module
Module advisor	Prof. Dr. Holger Karl
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	Participants of this module know techniques and procedures used in mobile communication networks. Depending on the choice of lectures, they are also experts in evaluating and optimizing such systems. It is highly recommended to choose at least one of the lectures Mobile Communication and Ad hoc and Sensor Networks.
Assessment modalities	One oral module exam
Remarks	—

3.9 Module: Networking Techniques

Module name	Networking Techniques
Courses	• Empiric Performance Evaluation (S. 120) • Future Internet (S. 124)
Module type	Elective module
Module advisor	Prof. Dr. Holger Karl
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module provides expertise in current development of modern communication architectures and the redesign of the Internet architecture. Depending on the choice of lectures in this module, emphasis can be put on conceptual/technological, algorithmic or performance evaluation aspects. It is highly recommended to choose at least one of the lectures Future Internet or Internet Algorithms.
Assessment modalities	One oral module exam
Remarks	—

3.10 Module: Networking Theory

Module name	Networking Theory
Courses	• Fortgeschrittene verteilte Algorithmen und Datenstrukturen (S. 123) • Routing and Data Management in Networks (S. 163)
Module type	Elective module
Module advisor	Prof. Dr. Christian Scheideler
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module focuses on theoretic foundations for the design and operation of communication networks. Special emphasis is on provable and guaranteeable properties of a network. Participants shall develop the ability to perform such proofs themselves.
Assessment modalities	One oral module exam
Remarks	—

3.11 Module: Optical Communication A

Module name	Optical Communication A
Courses	• Optical Communication A (S. 145)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Noe
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Optical Communications A” introduces into modern optical communications on which internet and telephony rely. After attending the course, the students will be able to • describe, model and apply the function of components, systems and effects of optical communications and • apply knowledge of optoelectronics.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.12 Module: Optical Communication B

Module name	Optical Communication B
Courses	• Optical Communication B (S. 147)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Noe
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Optical Communications B” gives an introduction into mode coupling in optical communications. After attending the course, the students will be able to • understand the meaning and importance of wave modes and mode coupling in optical communications, • make up and understand mathematical models of optical components and systems and • understand and abstract how optical components work
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.13 Module: Optical Communication C

Module name	Optical Communication C
Courses	• Optical Communication C (S. 149)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Noe
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module "Optical Communications C" focuses on modulation formats. After attending the course, the students will be able to • know and evaluate different modulation schemes in Optical Communications in their meaning, • see the importance of efficient modulation schemes in Optical Communications and • realize and develop efficient optical communication systems.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.14 Module: Optimale und adaptive Filter

Module name	Optimale und adaptive Filter
Courses	• Optimale und adaptive Filter (S. 152)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Optimal and adaptive filters” gives an introduction to the basic techniques and theories of adaptive filters. After attending the course, the students will be able to analyze tasks in the field of adaptive filters and to formulate requirements mathematically, develop filter using cost functions and implement selected adaptive filters in the frequency or time domain. GM
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.15 Module: Security

Module name	Security
Courses	• Cryptographic Protocols (S. 101) • Cryptography - Provable Security (S. 103) • Einführung in die Kryptographie (S. 118)
Module type	Elective module
Module advisor	Jun.-Prof. Dr. Christoph Sorge
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module covers problems and solutions for security in IT systems. It comprises theoretically oriented lectures on cryptography (as a main foundation for many security concepts) as well as lectures focusing on practical or (partially) on legal aspects.
Assessment modalities	One oral module exam
Remarks	—

3.16 Module: Wireless Communications

Module name	Wireless Communications
Courses	• Wireless Communications (S. 182)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	After completion of the module students will be able to • Develop a discrete-time statistical channel model for a given physical description of a wireless communication channel • Explain the techniques and algorithms used in the Physical Layer of a wireless communication system • Understand the fundamental design options an decisions taken to realize reliable communication over time variant and frequency selective or nonselective fading channels • Appreciate and categorize the techniques used in modern cellular communication systems to realize reliable communication • Trade off the advantages and disadvantages of different transmission techniques with respect to bandwidth and power efficiency as well as number of users to be served • Select and design an appropriate transmission technique for a wireless channel • simulate and analyze simple communication systems using modern software tools

	The students • Can transfer and apply the concept of linear vector spaces to signal processing tasks other than for wireless communications • Can apply the skills about the generation of data, simulation of systems and analysis of experimental results using modern software tools, that have been acquired in this course, to other disciplines • Can work cooperatively in a team and subdivide an overall task into manageable subtasks and work packages
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.17 Module: Computer Architecture

Module name	Computer Architecture
Courses	• Architektur paralleler Rechnersysteme (S. 98) • Massively Parallel Architectures (S. 137) • Metaheuristics for Hardware Evolution (S. 139) • Reconfigurable Computing (S. 157)
Module type	Elective module
Module advisor	Prof. Dr. Marco Platzner
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module covers the area of modern computer architecture. The two lectures Reconfigurable Computing and Massively Parallel Architectures address different technologies and architectures used in modern compute nodes and the corresponding design and programming approaches. The lecture HPC Architectures focuses on architecture and programming of parallel computers with an emphasis on high performance computing.
Assessment modalities	One oral module exam
Remarks	—

3.18 Module: Hardware Fault Tolerance

Module name	Hardware Fault Tolerance
Courses	• Hardware Fault Tolerance (S. 130)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Sybille Hellebrand
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module deals with methods and techniques of fault-tolerant hardware design and discusses current solutions in integrated circuit and system design. After the successfull completion of the module the students are able to explain, to evaluate, and to trade-off the basic redundancy techniques. They are familiar with complex approaches from industrial practice, and can develop fault tolerance concepts for smaller applications on their own.
Assessment modalities	One oral module exam
Remarks	—

3.19 Module: Large-scale IT systems

Module name	Large-scale IT systems
Courses	• Cloud Computing (S. 100) • Databases and Information Systems (S. 105) • Empiric Performance Evaluation (S. 120) • Future Internet (S. 124) • Processing, Indexing, and Compression of Structured Data (S. 155)
Module type	Elective module
Module advisor	Prof. Dr. Stefan Böttcher
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module considers the particular needs and challenges of large-scale IT systems. Depending on the choice of lectures, it is possible to focus on classic database systems or to also consider cloud computing aspects. It is highly recommended to choose the lecture Databases and Information Systems.
Assessment modalities	One oral module exam
Remarks	—

3.20 Module: Advanced Topics in Robotics

Module name	Advanced Topics in Robotics
Courses	• Advanced Topics in Robotics (S. 94)
Module type	Elective module
Module advisor	Prof. Dr. Bärbel Mertsching
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module "Advanced Topics in Robotics" is based on the module "Robotics". The students are introduced to current research topics in the field of autonomous and teleoperated mobile robots to solve interdisciplinary issues. The challenges encountered in developing intelligent mobile systems are analyzed and current solutions presented. After successfully completing the module the students • are able to name and analyze the basic robot architectures for mobile robots, • have a good command of the methods for the navigation and control of mobile robots and • are able to implement, test and apply them.
Assessment modalities	One oral module exam
Remarks	—

3.21 Module: Advanced Control

Module name	Advanced Control
Courses	• Advanced Control (S. 89)
Module type	Elective module
Module advisor	Dr. Björn Rüffer
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The course provides an overview of common design schemes used for various dynamic control applications. Students acquire an overview of the most prevalent controller design schemes and will gain practice in applying these techniques and implement them on a computer. They will gain the ability to apply the controller design scheme covered in this course to problems in electrical, mechanical engineering and other areas. Due to the broad spectrum of different schemes the students will build up a useful repertoire of techniques that allows them to solve even highly complex problems. E
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.22 Module: Biomedizinische Messtechnik

Module name	Biomedizinische Messtechnik
Courses	• Biomedizinische Messtechnik (S. 99)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students are able to understand the root causes and mechanisms of bioelectrical and biomagnetic signals and their propagation in a biological body. They understand the basics and applicability of electro-diagnostic procedures and can characterize important tomographic methods.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.23 Module: Digitale Reglungen

Module name	Digitale Reglungen
Courses	• Digitale Reglungen (S. 111)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students are able to mathematically analyse the dynamics of time-discrete systems and compare these dynamics with that of time-continuous systems. They can design and characterize control schemes to achieve a given, desired dynamics of a control loop.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.24 Module: Dynamic Programming and Stochastic Control

Module name	Dynamic Programming and Stochastic Control
Courses	• Dynamic Programming and Stochastic Control (S. 114)
Module type	Elective module
Module advisor	Dr. Alex Leong
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	After attending this course, students will have understood the basics of dynamic programming and stochastic control. Students will learn the dynamic programming optimality principle and how it can be used to solve multi-stage decision making problems. They will learn how to formulate and solve, using dynamic programming, problems in different areas such as control, communications, signal processing, and machine learning.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.25 Module: Flachheitsbasierte Regelungen

Module name	Flachheitsbasierte Regelungen
Courses	• Flachheitsbasierte Regelungen (S. 122)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	This module provides knowledge about the concept of setpoint control, a scheme highly important in industrial practice. Students are able to recognize and sketch a methodical development of a new control theoretic concept from known control components. They can ascertain advantages and disadvantages of a new concept can parameterize a control loop to achieve desired behavior.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.26 Module: Controlled AC Drives

Module name	Controlled AC Drives
Courses	• Geregelte Drehstromantriebe (S. 126)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Joachim Böcker
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module introduces the principle of flux-oriented control of three-phase AC motors, which is today's standard of electrical drives in industry. Unlike the course of the bachelor's program, focus is put on the dynamics behavior and on the control structures. The students will understand the most important types of AC drives, their properties and should be able to select and to design such drives by themselves.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.27 Module: Optische Messverfahren

Module name	Optische Messverfahren
Courses	• Optische Messverfahren (S. 154)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students can analyse complex tasks in the context of optical measurements and develop own solutions. They learn how to judge real properties of components, e.g., time behavior.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.28 Module: Regelungstechnik B

Module name	Regelungstechnik B
Courses	• Regelungstechnik B (S. 158)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students can • compare different feedback structures and dimension them properly to solve a given task, • analyse the dynamic behavior of feedback systems under the influence of limited set point choices, • design suitable control loops to improve the robustness of the control.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.29 Module: Regelungstheorie - Nichtlineare Regelungen

Module name	Regelungstheorie - Nichtlineare Regelungen
Courses	• Regelungstheorie - Nichtlineare Regelungen (S. 159)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	This module covers those parts of control theory necessary in non-linear systems. Emphasis is on the design of feedbacks for linearization and de-coupling of input and output of time-invariant multi-variable systems. Students will be able to • describe basics of differential-geometric methods • explain mathematical models of nonlinear dynamic systems (in state and descriptor representation), • apply those basic to models to solve challenging control-theoretic problems.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.30 Module: Robotik

Module name	Robotik
Courses	• Robotics (S. 161)
Module type	Elective module
Module advisor	Prof. Dr. Bärbel Mertsching
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Robotics” introduces basic concepts and techniques in the field of mobile robotics. The challenges for the development of autonomous intelligent systems will be analyzed and the current solutions will be presented. After successfully completing the module the students • know how to transfer basic methods from control and system theory to robotics and • are able to apply the adequate methods to describe as well as plan and control the movements of robot arms and mobile robots.
Assessment modalities	One oral module exam
Remarks	—

3.31 Module: Ultraschall-Messtechnik

Module name	Ultraschall-Messtechnik
Courses	• Ultraschall-Messtechnik (S. 178)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	This module treats mechanicals waves in solids, fluids, and gases. Main acoustic measurement principles and their application in industry are explained. Students will be able to apply ultrasound-based measurement techniques to determine both acoustic and non-acoustic properties.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.32 Module: Umweltmesstechnik

Module name	Umweltmesstechnik
Courses	• Umweltmesstechnik (S. 179)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students will be able to analyse mechanisms under increasing environmental problems, chose suitable measurements techniques, and characterize and analyze measurement results.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.33 Module: Algorithms and Tools for Test and Diagnosis of Systems on Chip

Module name	Algorithms and Tools for Test and Diagnosis of Systems on Chip
Courses	• Algorithms and Tools for Test and Diagnosis of Systems on Chip (S. 96)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Sybille Hellebrand
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Algorithms and Tools for Test and Diagnosis of Systems on a Chip” deals with recent approaches in test and diagnosis of integrated systems. The student work with research papers to extract and understand the underlying models and algorithms. They learn to explain the specific challenges of nanoscale integration and evaluate test strategies accordingly.
Assessment modalities	Manuscript and Oral Presentation
Remarks	—

3.34 Module: Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik

Module name	Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik
Courses	• Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik (S. 164)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Christoph Scheytt
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	With successful completion of the module the students will be able to • describe architectures and circuits of fast digital data transmission links, • describe and calculate fundamental signal transmission properties of digital systems, • apply design methods to design basic integrated broadband circuits, GM
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.35 Module: Real-time/Embedded Systems

Module name	Real-time/Embedded Systems
Courses	• Advanced Embedded Systems (S. 90) • Intelligenz in eingebetteten Systemen (S. 134) • Metaheuristics for Hardware Evolution (S. 139) • Reconfigurable Computing (S. 157)
Module type	Elective module
Module advisor	Prof. Dr. Franz Rammig
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module collects lectures on embedded and real-time systems. Successful participants of this module know the particular requirements of such systems (timeliness, dependability, integration into a technical process), can select appropriate solutions (e.g., scheduling algorithm) from a catalog and assess the suitability of such a choice as well as develop new solutions if required.
Assessment modalities	One oral module exam
Remarks	—

3.36 Module: SW-Engineering for Embedded Systems

Module name	SW-Engineering for Embedded Systems
Courses	• Model-Driven Software Development (S. 143) • Quantitative Evaluation of Software Designs (S. 156) • Software Quality Assurance (S. 166)
Module type	Elective module
Module advisor	Prof. Dr. Wilhelm Schäfer
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	4 SWS VL, 2 SWS UE
Credits ECTS	8
Work load	• 60 h contact hours lectures • 30 h contact hours exercises • 150 h self-study **240 h total workload**
Learning objectives	This module teaches knowledge about applying up-to-date software engineering methods in the design and development of embedded systems. Topics like testing and qualitative (constructive and analytic) quality assurance, as well as quantitative analysis techniques are possible.
Assessment modalities	One oral module exam
Remarks	—

3.37 Module: VLSI Testing

Module name	VLSI Testing
Courses	• Test hochintegrierter Schaltungen (S. 173)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Sybille Hellebrand
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The course “VLSI Testing” focuses on techniques for detecting hardware defects in micro-electronic circuits. After attending the course, the students will be able to • describe fault models, DFT techniques, and test tools, • explain and apply the underlying models and algorithms for fault simulation and test generation, • analyze systems with respect to their testability and to derive appropriate test strategies.
Assessment modalities	One oral module exam
Remarks	—

3.38 Module: Einführung in die Hochfrequenztechnik I

Module name	Einführung in die Hochfrequenztechnik I
Courses	• Einführung in die Hochfrequenztechnik I (S. 116)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Andreas Thiede
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The course Introduction to “High-Frequency Engineering” provides basic knowledge of high-frequency engineering. The students learn to describe circuits comprising distributed and lumped components, to analyze, and to design the latter. GM
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.39 Module: Halbleiterprozesstechnik

Module name	Halbleiterprozesstechnik
Courses	• Halbleiterprozesstechnik (S. 128)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Ulrich Hilleringmann
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Semiconductor Device Fabrication” focuses on the integration process of semiconductor devices. After attending the course, the students will be able to explain the most important methods for this and to manipulate them, to explain different CMOS-processes, and to develop specific integration flows. GM
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.40 Module: High Frequency Engineering

Module name	High Frequency Engineering
Courses	• High-Frequency Engineering (S. 132)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Noe
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “High Frequency Engineering” has the goal to enable the listeners for developing tasks e. g. of the high-frequency part of a mobile phone. After attending the course, the students will be able to • understand and apply the physics of high-frequency components, cirquits and systems, • develop systems and cirquits in the high-frequency and highest-frequency domain and • develop and make up electronic cirquits under consideration of high-frequency aspects.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.41 Module: Technologie hochintegrierter Schaltungen

Module name	Technologie hochintegrierter Schaltungen
Courses	• Technologie hochintegrierter Schaltungen (S. 171)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Ulrich Hilleringmann
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The course “Technology of highly integrated circuits” focuses on very large-scale integration of semiconductor devices. After attending the course, the students will be able to • choose Local Oxidation of Silicon method for integration of transistors and calculate layer thicknesses • explain the integration of nano-scale transistors • explain transistor manufracturing with SOI-Technology. • develop processes for circuits with bipolar transistors. • explain circuits in BiCMOS-Technology.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.42 Module: Advanced System Theory

Module name	Advanced System Theory
Courses	• Advanced System Theory (S. 92)
Module type	Elective module
Module advisor	Prof. Peter Schreier, PhD
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	After attending this module, students will be familiar with the most important concepts and results in linear system theory. Students will develop confidence in their ability to solve mathematical problems of analysis and design. Many of their timeless insights and intuitions about the dynamical behavior of systems will be drawn from this course. This course presents material broad enough so that students will have a clear understanding of the dynamical behavior of linear systems, including their power and limitations. This will allow students to apply the theory to other fields.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.43 Module: Algorithmen der Spracherkennung

Module name	Algorithmen der Spracherkennung
Courses	N/A
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	
Credits ECTS	6
Work load	
Learning objectives	Students will be able to explain and analyse modern algorithms of speech recognition and to program simple algorithms themselves.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.44 Module: Digital Image Processing I

Module name	Digital Image Processing I
Courses	• Digital Image Processing I (S. 107)
Module type	Elective module
Module advisor	Prof. Dr. Bärbel Mertsching
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Digital Image Processing I” provides a fundamental introduction to digital image processing. After successfully completing the module the students • are able to describe the basics of image generation and image digitization and • are able to implement, test and apply methods for the enhancement of images in the spatial and frequency domain, image segmentation and data reduction independently for complex image processing tasks
Assessment modalities	One oral module exam
Remarks	—

3.45 Module: Digital Image Processing II

Module name	Digital Image Processing II
Courses	• Digital Image Processing II (S. 109)
Module type	Elective module
Module advisor	Prof. Dr. Bärbel Mertsching
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Digital Image Processing II” follows the fundamental module “Digital Image Processing I” and describes methods for feature extraction and object recognition. After successfully completing the module the students • are able use the basic methods for image segmentation, • have a good command of the probabilistic methods for the description of image features and object recognition, • are able to transfer the acquired knowledge of image processing to the processing of other multi-dimensional signals and • are able to describe the state-of-the-art of the presented topics
Assessment modalities	One oral module exam
Remarks	—

3.46 Module: Digitale Sprachsignalverarbeitung

Module name	Digitale Sprachsignalverarbeitung
Courses	• Digitale Sprachsignalverarbeitung (S. 112)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The course introduces the basic techniques and theories of digital speech signal processing. After attending the course, the students will be able to • analyze digital signals, e.g., audio signals, in the time or frequency domain, • represent audio signals efficiently and • implement widely-used algorithms for speech analysis and speech processing in the frequency or time domain.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.47 Module: Kognitive Sensorsysteme

Module name	Kognitive Sensorsysteme
Courses	• Kognitive Sensorsysteme (S. 136)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students learn to analyse complex tasks in complex multi-variate data analysis and to develop own solutions. They will exercise using artificial neural networks for pattern recognition and interpolation.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.48 Module: Messstochastik

Module name	Messstochastik
Courses	• Messstochastik (S. 138)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Bernd Henning
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students can analyse and ascertain complex measurement tasks with stochastically varying values. They will develop own solutions. They can evaluate algorithms regarding computational efficiency, effectiveness, error behaviors and bounds.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.49 Module: Modellbildung, Identifikation und Simulation

Module name	Modellbildung, Identifikation und Simulation
Courses	• Modellbildung, Identifikation und Simulation (S. 144)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	This module teaches basics in analytic and numeric design of mathematical models and their treatment in numeric simulation. Students can compute parameters of an impulse response function based on measurement data, compute mathematical models analytically using computer algebra tools, and choose algorithms for numeric solutions.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.50 Module: Optimale Systeme

Module name	Optimale Systeme
Courses	• Optimale Systeme (S. 151)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students understand the relevance of variational calculus for optimal control, appreciate the importance of a matched problem statement, solve Riccati control and Kalman filter tasks for linear systems and simple non-linear systems.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.51 Module: Statistische Lernverfahren und Mustererkennung

Module name	Statistische Lernverfahren und Mustererkennung
Courses	• Statistische Lernverfahren und Mustererkennung (S. 167)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	The module “Statistical Learning and Pattern Recognition” presents an introduction into the components and algorithms prevalent in statistical pattern recognition. The presented techniques can be applied to a variety of classification problems, both for one-dimensional input data (e.g., speech), two-dimensional (e.g., image) or symbolic input data (e.g., documents). After completion of the module students will be able to • Choose an appropriate decision rule for a given classification problem • Apply supervised or unsupervised learning techniques to data of various kinds and critically assess the outcome of the learning algorithms • Work with dedicated pattern classification software (e.g., for artificial neural networks, support vector machines) on given data sets and optimize parameter settings • Find, for a given training set size, an appropriate choice of classifier complexity and feature vector dimensionality
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.52 Module: Systemtheorie - Nichtlineare Systeme

Module name	Systemtheorie - Nichtlineare Systeme
Courses	• Systemtheorie - Nichtlineare Systeme (S. 169)
Module type	Elective module
Module advisor	Prof. Dr. techn. Felix Gausch
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students will learn basics for stability evaluation in non-linear dynamic systems. They can understand differences in the dynamics of linear and non-linear systems, systematically determine stability of non-linear systems, understand the use of feedback control in non-linear systems.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.53 Module: Technische kognitive System

Module name	Technische kognitive System
Courses	• Technische kognitive Systeme (S. 170)
Module type	Elective module
Module advisor	Prof. Dr. Bärbel Mertsching
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Erfolgreiche Absolventen können, wissen, vermögen, ...
Assessment modalities	One oral module exam
Remarks	—

3.54 Module: Aktuelle Themen aus Mustererkennung und maschinellem Lernen

Module name	Aktuelle Themen aus Mustererkennung und maschinellem Lernen
Courses	• Topics in Pattern Recognition and Machine Learning (S. 175)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German & English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	After completion of the module students will be able to • Choose an appropriate classifier for a given classification problem and be able to learn the parameters of the classifier from training data • Choose an appropriate regression method for function approximation and learn its parameters from training data • Search for latent variables and structure in given data • Make an informative choice for the model order to find a good compromise between degree of detail and generalizabliliy • Comprehend and analyze recent publications from the field of pattern recognition and machine learning GM
Assessment modalities	One oral module exam
Remarks	—

3.55 Module: Topics in Signal Processing

Module name	Topics in Signal Processing
Courses	• Topics in Signal Processing (S. 177)
Module type	Elective module
Module advisor	Prof. Peter Schreier, PhD
Language	English
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	In this course, students will familiarize themselves with some current research topics in signal processing. They will learn to read and understand scientific publications and to critically evaluate results.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.56 Module: Verarbeitung statistischer Signale

Module name	Verarbeitung statistischer Signale
Courses	• Verarbeitung statistischer Signale (S. 21)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	Students will understand the relevant of statics of many areas of computer engineering. They can describe systems using stochastic methods, compute e.g. reliability, construct hypothesis test and parameter estimation schemes, compare experimental data, execute a spectral analysis, design optimal filers.
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

3.57 Module: Videotechnik

Module name	Videotechnik
Courses	• Videotechnik (S. 180)
Module type	Elective module
Module advisor	Prof. Dr.-Ing. Reinhold Häb-Umbach
Language	German
Implementation method	Lectures and Exercises
Contact hours (per week & semester)	2 SWS VL, 2 SWS UE
Credits ECTS	6
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Learning objectives	After attending the course, the students will be able to • analyze tasks in the field of basics of picture scannings and to formulate requirements mathematically, • describing of picture data reduction systems • declaring picture transmission systems. • describing basic principles of color The students • are able to check theoretical results using practical realizations, • are able to undertake theoretical approaches a systematic analysis using methodical procedures and • are, due to the precise treatment of the contents, in a position to continue their learning themselves
Assessment modalities	One oral or one written exam determines module grade
Remarks	—

Chapter 4

Course lists of elective modules

4.1 Advanced Control

Course	Advanced Control
Coordination	Dr. Björn Rüffer
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sst.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Advanced Control (S. 51)
Short description	
This course discusses the design and analysis of signal processing techniques for wireless communication systems. It is intended to serve students in engineering who have a basic knowledge of linear algebra and probability theory.	
Content	
Evolution of wireless communications, 3G/WiMAX, wireless channel models, interference and noise, digital modulation, linear receivers and implementations, coding and coded modulation, non-linear receivers and implementations, channel capacity, transmitter design.	
Learning objectives, competences	
After attending this course, students will be familiar with key signal processing techniques for modern wireless communication systems. Students will have developed an in-depth understanding of the modeling and treatment of signal processing problems in real-world communication systems. The fundamental principles and mathematical tools presented in this course can be applied to wider areas of signal processing.	
Implementation	
Lectures and exercises	
Recommended knowledge	
Basic knowledge of linear algebra and probability theory, introductory course in communications engineering is helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Handouts and tutorial questions will be announced in the first lecture	
Comments	
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4.2 Advanced Embedded Systems

Course	Advanced Embedded Systems
Coordination	Prof. Dr. Falko Dressler
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`htto://http://www.ccs-labs.org/`
Intended semester	To be announced
Modules using this course	Real-time/Embedded Systems (S. 65)
Short description	
This course provides specific concepts and implementation techniques for advanced embedded systems. The specific challenges of such systems are pointed out and resulting techniques to solve them are taught. By means of recent original publications it will be demonstrated how highly up to date concepts can be implemented efficiently.	
Content	
• Recent challenges in the context of Embedded Systems • Cyber Physical Systems • Cognitive approaches • Time-triggered vs. event-triggered solutions for distributed embedded systems • Embedded systems on Multicore architectures • Mixed Criticality Systems • Self-X concepts for embedded systems	
Learning objectives, competences	
The students • understand the most recent challenges in designing embedded systems • understand the basic concepts and are capable to further explore the field by studying the respective literature, • learn to apply the acquired knowledge and skills in an interdisciplinary manner • extend their capabilities in teamwork and cooperation. In addition they enhance their skills in presenting results by means of solving exercises.	

Implementation
Presentation supported by means of various media, discussion of original literature, exercises in teams, based on prepared problems
Recommended knowledge
Basic knowledge in embedded systems.
Assessment modalitites
Oral exam
Teaching Material, literature
The students get a list of relevant textbooks and selected original literature at the beginning of the course. All teaching material will be handed out in electronic form.
Comments
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4.3 Advanced System Theory

Course	Advanced System Theory
Coordination	Prof. Peter Schreier, PhD
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sst.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Advanced System Theory (S. 72)

Short description

Building on an undergraduate system theory course, this course studies the dynamical behavior of linear systems with greater mathematical rigor. The course is primarily intended to serve students in engineering, but it can also be useful to students in physics and other natural sciences.

Content

System models and differential equations, state-space and I/O descriptions, relations between internal and external descriptions, response of continuous- and discrete-time systems, stability, controllability, observability, state-space realizations of external descriptions, feedback systems

Learning objectives, competences

After attending this course, students will be familiar with the most important concepts and results in linear system theory. Students will develop confidence in their ability to solve mathematical problems of analysis and design. Many of their timeless insights and intuitions about the dynamical behavior of systems will be drawn from this course.

This course presents material broad enough so that students will have a clear understanding of the dynamical behavior of linear systems, including their power and limitations. This will allow students to apply the theory to other fields.

Implementation

Lectures and exercises (including some computer simulations)

Recommended knowledge

Recommended is a basic understanding of differential equations, linear algebra, and Laplace transforms, as they are covered in a typical undergraduate course on system theory.

Assessment modalitites

Oral exam

Teaching Material, literature

Handouts and tutorial questions, literature references will be given in the first lecture.

Comments

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4.4 Advanced Topics in Robotics

Course	Advanced Topics in Robotics
Coordination	Prof. Dr. Bärbel Mertsching
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://getwww.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Advanced Topics in Robotics (S. 50)

Short description

The course “Robotics” introduces basic concepts and techniques in the field of mobile robotics. The challenges for the development of autonomous intelligent systems will be analyzed and the current solutions will be presented.

Content

In detail the following topics are covered:
- Sensors, effectors, actuators
- Homogenous coordinates, general transformations, Denavit-Hartenberg parameters
- Kinematics and dynamics of robot arms and mobile robots

Learning objectives, competences

The students
- know how to transfer basic methods from control and system theory to robotics and
- are able to apply the adequate methods to describe as well as plan and control the movements of robot arms and mobile robots.

Furthermore, they are able to identify and evaluate the function and behavior of robots and their integration into the social and economic environment while also considering ethical aspects.

Implementation

- The theoretical and methodical fundamentals will be introduced during the lecture.
- The methods presented will be practiced during the subsequent exercise / lab part.
- Finally, the participants will implement, test, and apply simple algorithms.
- The necessary programming skills will be taught during the practical, this is explicitly not considered a programming course.

Recommended knowledge

None

Assessment modalitites

Oral exam

Teaching Material, literature

Allocation of lecture notes; information on textbooks stocked in the textbook collection will be announced later.
- Mertsching, Bärbel: Robotics (lecture notes)
- McKerrow, Phillip J.: Introduction to Robotics. Addison-Wesley, 1991
- Siegwart, Roland; Nourbakhsh, Illah R. and Scaramuzza, David: Introduction to Autonomous Mobile Robots. The MIT Press, 2011, ISBN-13: 978-0262015356

Comments

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4.5 Algorithms and Tools for Test and Diagnosis of Systems on Chip

Course	Algorithms and Tools for Test and Diagnosis of Systems on Chip
Coordination	Prof. Dr.-Ing. Sybille Hellebrand
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www.date.uni-paderborn.de/en/willkommen/`
Intended semester	Winter term and Summer term
Modules using this course	Algorithms and Tools for Test and Diagnosis of Systems on Chip (S. 63)

Short description

The course "Algorithms and Tools for Test and Diagnosis of Systems on Chip" deals with advanced topics in test and diagnosis of integrated systems. The focus is on algorithms and tools for computer-aided preparation and application of test and diagnosis procedures.

Content

Topics include but are not restricted to:
- Advanced techniques for built-in self-test and embedded test
- Built-in diagnosis
- Test of robust and self-adaptive systems
- Adaptive Testing

Learning objectives, competences

After attending the course, the students will be able
- to describe recent approaches in test and diagnosis,
- to explain and apply the underlying models and algorithms,
- to explain the specific challenges of nanoscale integration and evaluate test strategies accordingly.

Fachübergreifende Kompetenzen / Key qualifications

Die Studierenden können
- vorhandenes Grundlagenwissen zur selbständigen Erarbeitung neuer Inhalte einsetzen,
- die erarbeiteten neuen Inhalte in einem Fachvortrag präsentieren und
- die erarbeiteten neuen Inhalte in einer schriftlichen Ausarbeitung nach den Richtlinien wissenschaftlicher Fachartikel beschreiben.

Implementation
• Lecture based on slide presentation, extensions on blackboard • Self-study on recent approaches based on recent conference and journal publications • Oral presentation • Manuscript
Recommended knowledge
Digital Design, Algorithms
Assessment modalitites
Manuscript and Oral Presentation
Teaching Material, literature
• Slides • Publications • Michael L. Bushnell, Vishwani D. Agrawal, "Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits," Kluwer Academic Publishers, ISBN: 0792379918 • Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, "VLSI Test Principles and Architectures: Design for Testability," Morgan Kaufmann Series in Systems on Silicon, ISBN: 0123705975
Comments
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4.6 Architektur paralleler Rechnersysteme

Course	Architektur paralleler Rechnersysteme
Coordination	Dr. Jens Simon
Teaching Unit	Paderborn Center for Parallel Computing
Language	German
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://pc2.uni-paderborn.de/staff-board/staff/Jens_Simon/`
Intended semester	Winter term
Modules using this course	Clouds, Grids, and HPC (S. 36), Computer Architecture (S. 47)
Short description	
Text folgt noch	
Content	
Text folgt noch	
Learning objectives, competences	
Text folgt noch	
Implementation	
Text folgt noch	
Recommended knowledge	
Text folgt noch	
Assessment modalitites	
Text folgt noch	
Teaching Material, literature	
Text folgt noch	
Comments	
Text folgt noch	

4.7 Biomedizinische Messtechnik

Course	Biomedizinische Messtechnik
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Summer term
Modules using this course	Biomedizinische Messtechnik (S. 52)
Short description	
The lecture concentrates on determining measurements characterizing the physiological state of a human. Main methods are described and characterized, e.g., tomography.	
Content	
• Nervous system and skin; electrical processes • Blood and circulation • Electro-diagnostic methods • Tomography, sonography, audiometry	
Learning objectives, competences	
Students understand mechanisms of bioelectrical and biomedical signals and their propagation in the body. They can characterize and choose important tomography procedures.	
Implementation	
Lecture with slides and practical lab work.	
Recommended knowledge	
None	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Bereitstellung eines Skripts; Hinweise auf Lehrbücher aus der Lehrbuchsammlung werden bekannt gegeben.	
Comments	
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4.8 Cloud Computing

Course	Cloud Computing
Coordination	NN (W2-Stelle PC^2)
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://pc2.de`
Intended semester	To be announced
Modules using this course	Clouds, Grids, and HPC (S. 36), Large-scale IT systems (S. 49)
Short description	
This lecture covers typical usage scenarios for Cloud Computing, the structure and optimization options for clouds, typical middleware solutions, and the usage and programming of cloud-based applications.	
Content	
• Scenarios and use cases • How to build a cloud data centre: server structure, load balancing, resource management, cloud networking, economies of scale • Cloud middlewares, e.g., Nebula, OpenStack • Building cloud-based applications	
Learning objectives, competences	
Participants of this class obtain a double qualification: On the one hand, they will be able to develop and to optimize cloud-based applications; to choose from different cloud options and to rationalize this choice. On the other hand, they will be able to act as a cloud provider. They can design, operate, optimize, and debug a cloud center and develop and evaluate new algorithms and procedures for such a center.	
Implementation	
Lecture with slides and blackboard; homework assignments.	
Recommended knowledge	
Basic knowledge of distributed systems is highly recommended, e.g., a corresponding Bachelor-level class.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Slide set, publications.	
Comments	
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4.9 Cryptographic Protocols

Course	Cryptographic Protocols
Coordination	Prof. Dr. Johannes Blömer
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/de/fachgebiete/ag-bloemer.html`
Intended semester	Summer term
Modules using this course	Security (S. 44)
Short description	
We will discuss authentication schemes, protocols for identification and their variants. Afterwards, we will go into zero knowledge protocols. Finally, we will build numerous cryptographic primitives upon these techniques.	
Content	
• authentication and identification • pseudorandom functions, hash functions and message authentication codes • digital signatures, RSA signatures • identification protocols, Fiat-Shamir protocol, Schnorr protocol, Okamoto protocol • interactive protocols and zero-knowledge protocols	
Learning objectives, competences	
After attending the course • know fundamental security concepts and techniques from cryptography • are able to analyze the security of various techniques • are able to design simple methods from existing cryptographic primitives	
Implementation	
• lecture with beamer • exercises and homework	
Recommended knowledge	
• fundamental concepts from algorithm theory • fundamental concepts from complexity theory • fundamental concepts from probability	

Assessment modalitites
Oral exam
Teaching Material, literature
• slides • exercises • J. Katz, Y. Lindell, Introduction to Modern Cryptography, Chapman and Hall
Comments
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4.10 Cryptography - Provable Security

Course	Cryptography - Provable Security
Coordination	Prof. Dr. Johannes Blömer
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/de/fachgebiete/ag-bloemer.html`
Intended semester	Summer term
Modules using this course	Security (S. 44)

Short description

We discuss several advanced security concepts like semantic security and plaintext indistinguishability. We also describe several techniques to design cryptosystems that meet these strong security requirements. In particular, we discuss one-way functions, pseudorandom generators, and pseudorandom functions. Finally, we compare the security of cryptosystems used in practice (like AES and RSA) with advanced security concepts.

Content

- perfect secrecy and indistinguishable encryptions
- one-way functions and pseudorandom generators
- strong security notions and pseudorandom functions
- practical constructions of pseudorandom permutations
- trapdoor functions and asymmetric encryption

Learning objectives, competences

After attending the course the students
- know fundamental security concepts and techniques for symmetric and asymmetric encryption
- are able to analyze the security of encryption schemes
- are able to design and analyze simple cryptographic primitives

Implementation

- lecture with beamer
- exercises and homeworks

Recommended knowledge

- fundamental concepts from algorithm theory
- fundamental concepts from complexity theory
- fundamental concepts from probability

Assessment modalitites
Oral exam
Teaching Material, literature
• slides • exercises • J. Katz, Y. Lindell, Introduction to Modern Cryptography, Chapman and Hall
Comments
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4.11 Databases and Information Systems

Course	Databases and Information Systems
Coordination	Prof. Dr. Stefan Böttcher
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/ag-boettcher/lehre.html`
Intended semester	Summer term
Modules using this course	Large-scale IT systems (S. 49)
Short description	
Students become familiar with challenges and tasks of modern, large-scale databases. The lecture discusses standard solution techniques.	
Content	
• Data streams, string parsing, string compression (BWT, Wavelet Tree) • String indexing and search (suffix array, applications in search engines) • Column-oriented databases • Main memory databases • distributed and mobile databases • mobile transactions (atomicity, recovery, synchronization) • Query optimization	
Learning objectives, competences	
Students are able to correctly and efficiently use core components of databases systems and to avoid typical errors. They can design system components of database systems, understand, create, and implement search techniques for very large databases and their time and space complexity. Students are able to familiarize themselves with up-to-date research results from scientific publications.	
Implementation	
Lecture with slides, practical exercises using computers.	
Recommended knowledge	
• Programming in Java • Knowledge in databases, in particular transactions and relational algebra • Knowledge in data structures, in particular b-trees and hashing	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script based on lecture slides, scientific literature	
Comments	

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4.12 Digital Image Processing I

Course	Digital Image Processing I
Coordination	Prof. Dr. Bärbel Mertsching
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://getwww.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Digital Image Processing I (S. 74)
Short description	
The course "Digital Image Processing II" follows the fundamental course "Digital Image Processing I" and describes methods for feature extraction and object recognition.	
Content	
In detail the following topics are covered: • Wavelets and multiresolution processing (Image pyramids, Wavelet transforms) • Image segmentation (Line- and edge detection, thresholding, region-based segmentation, watershed algorithm, motion) • Representation and description (chain codes, signatures, contour descriptors, regional descriptors) • Stereo Image Analysis (depth perception, stereo geometry, correspondence problem) • Motion estimation (optical flow, motion models, motion segmentation) • Object recognition (object descriptions, classificators, probabilistic approaches)	
Learning objectives, competences	
The students • are able use the basic methods for image segmentation, • have a good command of the probabilistic methods for the description of image features and object recognition, • are able to transfer the acquired knowledge of image processing to the processing of other multi-dimensional signals and • are able to describe the state-of-the-art of the presented topics Furthermore, they are able to identify and evaluate the function and the behavior of complex technical processes and their integration into the social environment while also considering ethical aspects.	

Implementation
• The theoretical and methodic fundamentals will be introduced during the lecture. • During the subsequent exercise / lab part the participants will implement, test, and apply the presented methods
Recommended knowledge
Basic knowledge of image processing
Assessment modalitites
Oral exam
Teaching Material, literature
Lecture notes, exercise sheets and advanced literature (excerpt): • Mertsching, Bärbel: Digital Image Processing I (lecture notes) • Forsyth, David and Ponce, Jean: Computer Vision - A Modern Approach. Prentice Hall, 2nd ed., 2011. ASIN: B006V372KG • Gonzalez, Rafael C. and Woods, Richard E.: Digital ImageProcessing. Prentice Hall, 3rd ed., 2007. ISBN-13: 978-0131687288 • Jähne, Bernd: Digitale Bildverarbeitung. Springer, 7.Aufl., 2012. ISBN-13: 978-3642049514
Comments
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4.13 Digital Image Processing II

Course	Digital Image Processing II
Coordination	Prof. Dr. Bärbel Mertsching
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://getwww.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Digital Image Processing II (S. 75)
Short description	
The course "Digital Image Processing II" follows the fundamental course "Digital Image Processing I" and describes methods for feature extraction and object recognition.	
Content	
In detail the following topics are covered: • Wavelets and multiresolution processing (Image pyramids, Wavelet transforms) • Image segmentation (Line- and edge detection, thresholding, region-based segmentation, watershed algorithm, motion) • Representation and description (chain codes, signatures, contour descriptors, regional descriptors) • Stereo Image Analysis (depth perception, stereo geometry, correspondence problem) • Motion estimation (optical flow, motion models, motion segmentation) • Object recognition (object descriptions, classificators, probabilistic approaches)	
Learning objectives, competences	
The students • are able use the basic methods for image segmentation, • have a good command of the probabilistic methods for the description of image features and object recognition, • are able to transfer the acquired knowledge of image processing to the processing of other multi-dimensional signals and • are able to describe the state-of-the-art of the presented topics Furthermore, they are able to identify and evaluate the function and the behavior of complex technical processes and their integration into the social environment while also considering ethical aspects.	

Implementation
• The theoretical and methodic fundamentals will be introduced during the lecture. • During the subsequent exercise / lab part the participants will implement, test, and apply the presented methods
Recommended knowledge
Basic knowledge of image processing
Assessment modalitites
Oral exam
Teaching Material, literature
Lecture notes, exercise sheets and advanced literature (excerpt): • Mertsching, Bärbel: Digital Image Processing I (lecture notes) • Forsyth, David and Ponce, Jean: Computer Vision - A Modern Approach. Prentice Hall, 2nd ed., 2011. ASIN: B006V372KG • Gonzalez, Rafael C. and Woods, Richard E.: Digital ImageProcessing. Prentice Hall, 3rd ed., 2007. ISBN-13: 978-0131687288 • Jähne, Bernd: Digitale Bildverarbeitung. Springer, 7.Aufl., 2012. ISBN-13: 978-3642049514
Comments
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4.14 Digitale Reglungen

Course	Digitale Reglungen
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Digitale Reglungen (S. 53)
Short description	
Basic design and analysis of feedback systems. Limited to linear control; feedback in time-discrete systems. Basic for project work and final thesis.	
Content	
Digital control in linear systems. Mathematical treatment and design of control loops.	
Learning objectives, competences	
Students can use mathematical methods to describe time discrete systems, analyse their dynamics and compare it to time-continuous systems. Design control loops.	
Implementation	
Lecture with blackboard; homework; demonstration with real systems.	
Recommended knowledge	
Basics on control theory are helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script, textbooks.	
Comments	
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4.15 Digitale Sprachsignalverarbeitung

Course	Digitale Sprachsignalverarbeitung
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Summer term
Modules using this course	Digitale Sprachsignalverarbeitung (S. 76)

Short description

The course introduces the basic techniques and theories of digital speech signal processing. A focal point of the first part of the lecture is the topic "Listening and Speaking", which is concerned with psychological effects of human sound perception and speech production. Subsequently, time discrete signals and systems, as well as computer based data processing are discussed. Further topics are non-parametric short-time analysis of speech signals, speech coding and IP-phones.

Content

- Listen and talk
  - Generating voice: human vocal tract, source filter model, vocoder
  - Acoustic waves
  - Listen: human ear, psycho acoustics and physiology of listening, loudness, acoustic occlusion, frequency groups
- Time-discrete signals and systems
  - Basics: Elementary signals, LTI systems
  - Transformations: Fourier transformation of time-discrete signals, DFT, FFT
  - Time-discrete filtering in frequency domain: Overlap-Add, overlap-Save
- Statistical speech signal analysis
  - Basics in theory of probabilities
  - Short-run analysis of speech signals: Spectrogram, cepstrum
- Estimation of speech signals
  - Optimal filters
  - LPC analysis
  - Spectral filtering for noise suppression: spectral subtraction, Wiener filter
  - Adaptive Filters: LMS adaptation algorithm, echo compensation
- Speech coding
  - Time domain coding: signal shape coding, parametric coding, hybride coding techniques
  - Frequency domain coding
  - Amplitude quantization: uniform quantization, quantization with companders (μlaw, alaw)

Learning objectives, competences
After attending the course, the students will be able to • analyze digital signals, e.g., audio signals, in the time or frequency domain, • represent audio signals efficiently and • implement widely-used algorithms for speech analysis and speech processing in the frequency or time domain. The students • are able to explain effects in real signals based on the theoretical knowledge, • are able to investigate theoretical approaches by a systematic analysis and • are, due to the precise treatment of the contents, in a position to continue their learning themselves.
Implementation
• Lectures using the blackboard and presentations, • Alternating theoretical and practical exercise classes with exercise sheets and computer and • Demonstration of real technical systems in the lecture hall.
Recommended knowledge
Prior knowledge from the module Higher Mathematics is helpful.
Assessment modalitites
Oral exam
Teaching Material, literature
Allocation of a script; information on textbooks ; matlab scripts
Comments
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4.16 Dynamic Programming and Stochastic Control

Course	Dynamic Programming and Stochastic Control
Coordination	Dr. Alex Leong
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://controlsystems.upb.de/en/home.html`
Intended semester	Winter term
Modules using this course	Dynamic Programming and Stochastic Control (S. 54)

Short description

Dynamic programming is a method for solving decision making problems consisting of a number of stages, by breaking down the problem into simpler sub-problems. These methods have wide applicability in areas such as optimization, control, communications, and machine learning. This course will cover the modelling and solution of problems of sequential decision making under uncertainty. We will consider problems with both a finite and an infinite number of stages, as well as cases with perfect and imperfect observations of the system. Numerical techniques for solving these problems will be described, including suboptimal methods for when the state and/or action spaces are large.

Content

- The dynamic programming principle and dynamic programming algorithm
- Problems with perfect state information
- Problems with imperfect state information
- Infinite horizon problems
- Suboptimal methods and approximate dynamic programming

Applications to problems in control, communications, signal processing and machine learning, including current research, will be given throughout the course.

Learning objectives, competences

After attending the course, the students will will have understood the basics of dynamic programming and stochastic control. Students will learn the dynamic programming optimality principle and how it can be used to solve multi-stage decision making problems. They will learn how to formulate and solve, using dynamic programming, problems in different areas such as control, communications, signal processing, and machine learning.

Implementation

Lectures and exercises

Recommended knowledge

Basic knowledge on control of discrete-time systems, e.g. as covered in the course Regelungstechnik A - Automatic Control. An introductory course on probability and random processes, e.g. the course Stochastik für Ingenieure.

Assessment modalitites
Written exam
Teaching Material, literature
The main text will be: D. Bertsekas, Dynamic Programming and Optimal Control, Vol I, 3rd Ed, Athena Some other material will be taken from: • D. Bertsekas, Dynamic Programming and Optimal Control, Vol II, 4th Ed, Athena Scientific, 2012 • M. Puterman, Markov Decision Processes, John Wiley and Sons, 1994 • B. Anderson and J. Moore, Optimal Filtering, Prentice-Hall, 1979 • various research papers
Comments
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4.17 Einführung in die Hochfrequenztechnik I

Course	Einführung in die Hochfrequenztechnik I
Coordination	Prof. Dr.-Ing. Andreas Thiede
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://groups.uni-paderborn.de/hfe/`
Intended semester	Winter term
Modules using this course	Einführung in die Hochfrequenztechnik I (S. 68)

Short description

The course "Introduction to High-Frequency Engineering" provides basic knowledge of high-frequency engineering in particular with respect to signal propagation along transmission lines on circuit boards and integrated circuits.

Content

In the first part of the course Introduction to High-Frequency Engineering, an equivalent circuit togehther with primary transmission line parameter is introduced. The resulting telegraph equation is solved for various boundary conditions. In particular, stationary processes and lossless transmission lines are considered and the Smith diagram is introduced. The gained knowledge is used to dimension circuits comprising distributed and lumped components, in particular matching networks. In the second part, high-frequency aspects of circuit theory are covered. In particular, circuits comprising distributed and lumped elements are consistently described and classified by scattering parameters, and gain definitions are derived.

Learning objectives, competences

After attending the course, the students will be able to
- describe circuits comprising distributed and lumped components,
- to analyze,
- and to design the latter.

The students
- can use of methodic knowledge for systematic problem analysis,
- get familiar with the CAD system ADS, which is commonly used in industry
- and gain foreign language competences related to the field.

Implementation

- Lectures with black board presentation, supported by animated graphics and transparencies,
- Presence exercises with task sheets to be solved by the students together, supported by the teacher, and partially using CAD software.

Recommended knowledge
Higher Mathematics and Foundations of Electrical Engineering
Assessment modalitites
Oral exam
Teaching Material, literature
A. Thiede, Einführung in die Hochfrequenztechnik, Vorlesungsskript Universität Paderborn Continuative and deepening literature • P. Vielhauer, Lineare Netzwerke, Verlag Technik und Hüthig (65 YCF 1469) • M. Hoffmann, Hochfrequenztechnik, Springer Verlag (51 YDA 1913) • O. Zinke, H. Brunswig, Hochfrequenztechnik, Bd.1+2, Springer Verlag (51 YDA 1086) • G. Gonzalez, Microwave Transistor Amplifiers, Prentice Hall (51 YEP 3142) • P.C.L. Yip, High-Frequency Circuit Design and Measurements, Chapman & Hall (51 YDA 1751) • R.E. Collin, Foundations for Microwave Engineering, Mc Graw-Hill (51 YGA 1240)
Comments
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4.18 Einführung in die Kryptographie

Course	Einführung in die Kryptographie
Coordination	Prof. Dr. Johannes Blömer
Teaching Unit	Department of Computer Science
Language	German
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/de/fachgebiete/ag-bloemer.html`
Intended semester	Summer term
Modules using this course	Security (S. 44)

Short description

The goal of cryptography is the secure transfer and storage of data. Modern cryptography is a key technology with applications in mobile communication, electronic cash and e-commerce. In the course main techniques and methods from cryptography and the underlying security concepts are discussed.

Content

- symmetric encryption
- perfect secrecy
- block cipher and modes of operation
- asymmetric encryption
- integrity and hash functions
- message authentication codes
- digital signatures

Learning objectives, competences

After attending the course the students
- know the main security concepts and techniques from cryptography
- are able to identify appropriate techniques to achieve various goals of cryptography
- are able to design and analyze simple methods and protocols

Implementation

- lecture with beamer
- exercises and homeworks

Recommended knowledge

- fundamentals concepts from algorithm theory
- fundamental concepts from complexity theory
- methods from elementary number theory

Assessment modalitites
Oral exam
Teaching Material, literature
• slides • exercises • J. Buchmann, EinfÃ¼hrung in Kryptographie, Springer-Verlag.
Comments
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4.19 Empiric Performance Evaluation

Course	Empiric Performance Evaluation
Coordination	Prof. Dr. Holger Karl
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://wwwcs.upb.de/cs/cn/`
Intended semester	Winter term
Modules using this course	Mobile Networks (S. 37), Networking Techniques (S. 38), Clouds, Grids, and HPC (S. 36), Large-scale IT systems (S. 49)

Short description

This lecture discusses methods and procedures to conduct experimental and simulation-based performance evaluations, along with a statistically solid evaluation of results. The techniques of this class are applicable to a wide range of systems.

Content

- Classification of systems and models, in particular discrete event systems
- Structure of simulation programs, usual execution of simulations, use of pseudo-random numbers
- Extracting stochastic models from existing data: develop a distribution hypothesis, estimate parameters using maximum likelihood estimators, formulation of hypotheses, goodness of fits tests (e.g., χ^2 test), handling correlation, covariance stationarity
- STeady state, removal of initial transients, confidence intervals for independent and correlated results (e.g., batch means procedure)
- Models for correlated stochastic processes (Markov, ARIMA)
- Interpretation of confidence intervals, using them for system comparison
- Planning experiments with factorial designs

Learning objectives, competences

Participants can determine whether a given system or modell is amenable to a particular performance evaluation method. They can design an experiment or a simulation and execute it; they can choose a suitable stochastic model and interprete the experimental results correctly. They can derive statistically justified conclusions, e.g., which system can be regarded as the best system out of a given collection.

Implementation

Lecture with slides and blackboard; homework assignments.

Recommended knowledge

Bachelor-level stochastic.

Assessment modalitites

Oral exam

Teaching Material, literature

Slides, homework assignments, textbook Kelton & Law, Simulation Modelling and Analysis.

Comments
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4.20 Flachheitsbasierte Regelungen

Course	Flachheitsbasierte Regelungen
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Flachheitsbasierte Regelungen (S. 55)
Short description	
This lecture provides knowledge about the concept of setpoint control, a scheme highly important in industrial practice. Students are able to recognize and sketch a methodical development of a new control theoretic concept from known control components. They can ascertain advantages and disadvantages of a new concept can parameterize a control loop to achieve desired behavior.	
Content	
Details on set point control. Theory of exact input/output linearization; trajectory planing; design.	
Learning objectives, competences	
Students recognize components of a control-theoretic concept, can evaluate advantages and disadvantages, can design and parameterize suitable control loops, in particular, using set point approaches.	
Implementation	
Lecture with blackboard, homework assignments, demonstration using real-life technical systems.	
Recommended knowledge	
Control theory basics are helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script, textbooks.	
Comments	
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4.21 Fortgeschrittene verteilte Algorithmen und Datenstrukturen

Course	Advanced Distributed Algorithms and Data Structures
Coordination	Prof. Dr. Christian Scheideler
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	http://www.cs.uni-paderborn.de/fachgebiete/fg-ti/lehre0/ss2012/avads.html
Intended semester	Summer term
Modules using this course	Networking Theory (S. 39), Clouds, Grids, and HPC (S. 36)
Short description	
The lecture presents various distributed algorithms and data structures for Internet-based distributed systems. The emphasis will be on approaches that are not just self-stabilizing but that can also take locality, heterogeneity, and robustness into account.	
Content	
The lecture is structured as follows: • Network theory and routing • Locality • Heterogeneity • Robustness	
Learning objectives, competences	
The goal of the lecture is to introduce the students to techniques and approaches that allow that to design and analyze self-stabilizing distributed data structures that can take locality, heterogeneity, and robustness into account.	
Implementation	
Lecture with slides	
Recommended knowledge	
Helpful but not mandatory: Distributed Algorithms and Data structures	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
The lecture is based on recent publications in scientific conferences and journals. So far, no book is available that covers the topics of the lecture.	
Comments	
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4.22 Future Internet

Course	Future Internet
Coordination	Prof. Dr. Holger Karl
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://wwwcs.upb.de/cs/cn/`
Intended semester	Summer term
Modules using this course	Mobile Networks (S. 37), Networking Techniques (S. 38), Clouds, Grids, and HPC (S. 36), Large-scale IT systems (S. 49)
Short description	
This lecture deals with up-to-date, close-to-research developments in the Future Internet context. The lecture is dynamically updated to reflect current research and is predominantly based on research publications.	
Content	
Topics are much more dynamic than in typical lectures. Possible topics: • Information-centric networking • Optical networking, IP over fibre, MPLS • Open flow, software-defined networking • Inter-domain routing	
Learning objectives, competences	
Participants of this class are introduced to the current state of the art in Internet research. They know weaknesses of today's architecture, can criticize them and contrast them with current proposals as well as discuss and assess advantages and disadvantages. For different usage scenarios, they can predict the suitability of different solution proposals. Methodically, they can design and execute networking experiments. Participants can create new Internet protocols and synthesize them into new architectures; they can compare such creations with competing approaches and assess and decide for a superior solution. Since the lecture is based on scientific publications, participants are able to make use of original work that has not been didactically prepared.	
Implementation	
Lecture with slides and blackboard; homework assignments. The homework assignments will include architecture experiments, e.g., based on OpenFlow.	
Recommended knowledge	
Basic knowledge of computer networks is required, e.g., a Bachelor-level class "Computer networks".	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Slide set, but mostly based on current publications.	

Comments
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4.23 Geregelte Drehstromantriebe

Course	Controlled AC Drives
Coordination	Prof. Dr.-Ing. Joachim Böcker
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://wwwlea.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Geregelte Drehstromantriebe (S. 56)

Short description

The course introduces the principle of flux-oriented control of three-phase AC motors, which is today's standard of electrical drives in industry. Unlike the course of the bachelor's program, focus is put on the dynamics behavior and on the control structures. As most important examples, the permanent magnet synchronous motor and the induction motor are treated.

Content

- AC drives: Synchronous and induction motor (structure, basic physical effects, modeling, equivalent circuit diagrams, characteristic curves, operation areas)
- Speed and torque control
- Space vector theory (fundamental wave, coordinate transformation)
- Principles of flux-oriented control
- Closed-loop control of current, torque and speed, design methods
- Direct Torque Control (DTC)
- Observers
- Applications in industry, road and rail vehicles

Learning objectives, competences

- The students will understand the most important types of AC drives, their properties and should be able to select and to design such drives by themselves

- The students learn to transfer the learned skills also to other disciplines,
- extend their cooperation and team capabilities as well as the presentation skills in the context of solving the exercises
- learn strategies to acquire knowledge from literature and internet

Implementation

Parts of the course are organized as computer-based exercises

Recommended knowledge

None

Assessment modalitites

Oral exam
Teaching Material, literature
Lecture notes, slides. Other literature will be given in the lecture.
Comments
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4.24 Halbleiterprozesstechnik

Course	Halbleiterprozesstechnik
Coordination	Prof. Dr.-Ing. Ulrich Hilleringmann
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sensorik.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Halbleiterprozesstechnik (S. 69)

Short description

The course “Semiconductor Device Fabrication” focuses on the integration process of semiconductor devices. Starting from the cleaning process of the silicon crystal to the fabrication of integrated semiconductor circuits. This includes thermal oxidation, lithography, etching, doping, deposition and cleaning. Combinations of these steps to form the integration of MOS-transistors and CMOS-circuits are shown and can be experienced during the tutorials. The wafer dicing, bonding and packaging of microelectronic circuits complete the course.

Content

In detail the following topics are covered:
- Fabrication of Silicon-Wafers
- Oxidation
- Lithography
- Etching
- Doping
- Depositing
- Metallization and contacts
- Cleaning steps
- MOS-Technology for integrated circuits

Learning objectives, competences

After attending the course, the students will be able
- to explain the above listed methods and to manipulate them,
- to explain different CMOS-processes
- to develop specific integration flows.

The students
- are able to apply the practiced strategies for problem solving across varying disciplines,
- have experience in presenting their solutions to their fellow students, and
- know how to improve their competences by private study.

Implementation
• Lecture based on slide presentation, extensions on blackboard • Exercises in small groups based on exercise sheets with students presenting their own solutions
Recommended knowledge
Semiconductor Devices
Assessment modalitites
Oral exam
Teaching Material, literature
• Handouts of lecture slides • Hilleringmann: Silizium-Halbleitertechnologie • Schumicki, Seegebrecht: Prozesstechnologie • Widmann, Mader: Technologie hochintegrierter Schaltungen • Additional links to books and other material available at the webpage
Comments
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4.25 Hardware Fault Tolerance

Course	Hardware Fault Tolerance
Coordination	Prof. Dr.-Ing. Sybille Hellebrand
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www.date.uni-paderborn.de/en/willkommen/`
Intended semester	Winter term
Modules using this course	Hardware Fault Tolerance (S. 48)

Short description

The course “Hardware Fault Tolerance” deals with methods and techniques of fault-tolerant hardware design and discusses current solutions in integrated circuit and system design.

Content

In detail the following topics are covered:
- Basic terminology and redundancy techniques
- Error correcting codes and online monitoring
- Self-checking circuits
- Robust latches and flip-flops
- Software-based fault tolerance
- Fault tolerance in modern memory technologies
- Verification of fault tolerance properties

Learning objectives, competences

After attending the course, the students will be able to
- explain the terminology and basic redundancy techniques,
- understand complex solutions from industrial practice and apply them to similar applications,
- develop new fault tolerance strategies for smaller applications.

The students
- are able to apply the practiced strategies for problem solving across varying disciplines,
- have experience in presenting their solutions to their fellow students, and
- know how to improve their competences by private study.

Implementation

- Lecture based on slide presentation, extensions on blackboard
- Exercises in small groups based on exercise sheets with students presenting their own solutions
- Hands-on exercises using various software tools

Recommended knowledge
Knowledge from the Bachelor course “Qualitätssicherung” is helpful.
Assessment modalitites
Oral exam
Teaching Material, literature
• Handouts of lecture slides • I. Koren and C. M. Krishna, Fault-Tolerant Systems, Morgan-Kaufman, 2007 • P. K. Lala, Self-Checking and Fault-Tolerant Digital Design, Morgan Kaufmann Publishers, 2001 • D.K. Pradhan, Fault-Tolerant Computer Design, Prentice Hall, 1996 • R.N. Rao, E. Fujiwara, Error Control Coding for Computer Systems, Prentice Hall, 1989 • M.L. Bushnell, V.D. Agrawal, Essentials of Electronic Testing, Kluwer Academic Publishers, 2000 • Additional links to books and other material available at the webpage
Comments
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4.26 High-Frequency Engineering

Course	Hochfrequenztechnik
Coordination	Prof. Dr.-Ing. Reinhold Noe
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ont.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	High Frequency Engineering (S. 70)
Short description	
The course "High Frequency Engineering" has the goal to enable the listeners for developing tasks e. g. of the high-frequency part of a mobile phone. High-frequency engineering aspects have to be considered also in common digital cirquits. The main issues of this lecture are passive cirquits, high-frequency properties of transistor cirquits, linear and nonlinear amplifiers, noisy multi-port devices, mixers, oscillators, synchronization and phase locked loop.	
Content	
High-frequency engineering: This course begins with an introduction into the basics of high-frequency engineering like transmission line theory, scattering parameter and multi-port devices as well as impedance matching (Smith chart). Different types of transmission lines like strip lines, microstrip lines, coaxial lines and waveguides are dealt with. Furthermore, issues as high-frequency amplifiers e.g.with bipolar transistors or field effect transistors (FET) belong to this course as well as the dimensioning in cirquits, stability, noise and impedance matching. Further issues are mixers, oscillators but also the electromagnetic theory and it's application for waveguides, antennas and coupled TEM-lines.	
Learning objectives, competences	
After attending the course, the students will be able to • understand and apply the physics of high-frequency components, cirquits and systems, • develop systems and cirquits in the high-frequency and highest-frequency domain and • develop and make up electronic cirquits under consideration of high-frequency aspects. The students • are able to apply the knowledge and skills to a wide range of disciplines, • are able to make use of a methodical procedure when undertaking systematic analysis and • are, due to the abstract and precise treatment of the contents, in a position to continue and develop their learning themselves.	

Implementation
• Lectures using presentations via transparencies, • Exercise classes with exercise sheets and demonstrations on computer.
Recommended knowledge
Higher Mathematics, Physics, and the Foundations of Electrical Engineering
Assessment modalitites
Oral exam
Teaching Material, literature
Meinke, H.; Gundlach, F.: Taschenbuch der Hochfrequenztechnik, Springer, 2006 German only
Comments
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4.27 Intelligenz in eingebetteten Systemen

Course	Intelligenz in eingebetteten Systemen
Coordination	Dr. Bernd Kleinhohann
Teaching Unit	Department of Computer Science
Language	German
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www2.cs.uni-paderborn.de/cs/ag-rammig/www/members/berndk/berndk.html`
Intended semester	Summer term
Modules using this course	Real-time/Embedded Systems (S. 65)

Short description

The increasing availability of different sensors and actors in technical system leads to the integration of more and more sophisticated and intelligent behaviour into these systems, which is typically realized by embedded software. This lecture will present problems, methods and algorithms for realizing such intelligent functions in embedded systems. Examples systems from various domains like the automotive domain, telecommunications or robotics will be used to illustrate the concepts.

Content

- Application scenarios and architectures
- Computer vision
- Sensor fusion
- Maps and navigation
- reactive agents/behaviour based computing, affective computing
- Planning and foundations of cooperative actions
- Learning (Reinforcement learning, bayes learning)
- In the context of embedded systems, real-time and resource consumption will be important aspects of investigation for the presented methods and algorithms.

Learning objectives, competences

After this course students know methods and algorithms for intelligent sensor processing and planning/control of actions. They understand and can solve problems arising when realizing them in embedded systems. Furthermore, they are able to understand, use and adapt new methods and algorithms especially in the context of embedded systems.

Implementation

Lecture with slides; Interactive exercises, where students deepen their understanding and apply their knolwledge obtained in the lectures.

Recommended knowledge

Basic understanding of embedded systems

Assessment modalitites

Oral exam

Teaching Material, literature
Lecture slides. Other literature (books, publications; will be given in the lecture).
Comments
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4.28 Kognitive Sensorsysteme

Course	Kognitive Sensorsysteme
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Winter term
Modules using this course	Kognitive Sensorsysteme (S. 77)

Short description

The lecture discusses how (possibly massive) amounts of information can be suitably reduced. Tasks include detection, classification or identification. Techniques from multivariate data analysis and artificial neural networks are relevant tools.

Content

- Information fusion, sensor integration, data fusion
- Principal component analysis
- Artificial neural networks

Learning objectives, competences

Students can analyse complex tasks from multivariate data analysis and develop their own solutions for them. They can use artificial neural networks for pattern recognition and interpolation.

Implementation

Lecture with interactive whiteboard, practical lab exercises, students prepare small presentations and lead discussions.

Recommended knowledge

None

Assessment modalitites

Oral exam

Teaching Material, literature

Supplementary material and textbooks.

Comments

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4.29 Massively Parallel Architectures

Course	Massively Parallel Architectures
Coordination	Jun.-Prof. Dr. Christian Plessl
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://homepages.uni-paderborn.de/plessl/`
Intended semester	Winter term
Modules using this course	Computer Architecture (S. 47)

Short description

The course "Massively Parallel Architectures" deals with established and emerging massively parallel processor and computer architectures. The course coves both, the hardware architecture of massively parallel architectures as well as design and compilation methods for such architectures.

Content

- Kinds of parallelism
- Examples of massively parallel architectures (e.g., GPUs, many-cores, vector processors, systolic arrays, connection machine)
- Compilation and optimization methods for massively parallel architectures (e.g., polyhedral methods)
- Practical use of massively parallel architectures

Learning objectives, competences

After this course the participants are able to define different kinds of parallelism and to analyze application with respect to this kinds of parallelism. They know a set of representative architectures and can characterize the specific properties of these architecture. They are able to discuss different compilation and optimization methods and can apply them to the kernels of applications. They can practically apply and transfer their knowledge about parallelism, architectures and compilation in case studies, where applications are optimized or implemented for massively parallel architectures.

Implementation

Lecture with slides and blackboard; computer labs; homework assignments.

Recommended knowledge

Basic knowledge in Computerarchitecture; Course HW/SW Codesign (recommended)

Assessment modalitites

Oral exam

Teaching Material, literature

Slides; selected research papers.

Comments

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4.30 Messstochastik

Course	Messstochastik
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Summer term
Modules using this course	Messstochastik (S. 78)

Short description

The lecture discusses how random fluctuations can be treated by statistical methods, e.g., spectral analysis or correlation techniques. Errors regarding time and quantization are discussed. Practical use in communication and automation is highlighted. Accompanying exercises with lab and Matlab.

Content

- Basic of measurement stochastic
- Stochastic processes in non-linear systems
- Tools and devices
- Problems of finite measurement time
- Applications

Learning objectives, competences

Students can analyse complex measurement tasks with stochastically varying observables; evaluate these tasks and develop their own solutions. They can systematically analyze problems and familiarize themselves with new work areas.

Implementation

Lecture with interactive whiteboard, homework assignments and lab exercises for practical measurement experiments.

Recommended knowledge

Knowledge of module “Messtechnik” are helpful.

Assessment modalitites

Oral exam

Teaching Material, literature

Supplementary material and textbooks.

Comments

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4.31 Metaheuristics for Hardware Evolution

Course	Metaheuristics for Hardware Evolution
Coordination	Dr. Paul Kaufmann
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/computer-engineering-group/`
Intended semester	Summer term
Modules using this course	Computer Architecture (S. 47), Real-time/Embedded Systems (S. 65)

Short description

Many engineering tasks surpass the creativity and innovation capacity of humans because these tasks are too large and complex, have neither useful formal representation nor simulation models, or there is simply no intuition about how to solve these tasks. Nevertheless, these tasks need a solution. Very often, such challenges can be solved by Metaheuristics, a family of optimization algorithms based on the principles of analogy, induction and decomposition and inspired by mechanisms of the world that surrounds us, such as the annealing process in metallurgy and the biological evolution of species.

The lecture introduces modern Metaheuristics, such as the Variable Neighborhood Search, Genetic Algorithms, Particle Swarm Optimization, and Simulated Annealing and shows how these methods can be used to create chip designs, optimize circuits, and build run-time adaptable hardware.

Content

The lecture covers the following algorithmic topics
- The basic notion of Optimization
- Gradient / Steepest Descent and Hill Climbing
- Statistical analysis for Metaheuristics
- The Metropolis Algorithm, Simulated Annealing, Tabu Search, Variable Neighborhood Search
- Genetic Algorithms, Evolutionary Strategies, Genetic Programming
- Particle Swarm Optimization, Ant Colony Optimization
- Multi-objective Evolutionary Algorithms
- Neural Networks

The lecture covers the following application cases
- Floorplanning
- Placement
- High Level Synthesis Design Space Exploration
- Evolvable Hardware
- Hardware Neural Networks
- Approximate Computing

The labs cover the following implementation exercises
- Algorithms for floorplanning and placement
- SmartGrid optimization (network extension and restoration)

Learning objectives, competences
After this course the participants are able to • explain the principles and apply modern metaheuristics, • classify and formalize optimization tasks, • define goal functions and constraints, • propose solution approaches, and • identify essential challenges of the automatic design, optimization, and adaptation of digital circuits and modern computer systems.
Implementation
Lecture with slides and blackboard; homework assignments; programming assignments
Recommended knowledge
Basic knowledge in computer architectures and programming languages
Assessment modalitites
Oral exam
Teaching Material, literature
Slides; selected research papers; text books (complementary) • Weicker, Karsten, “Evolutionäre Algorithmen”, Springer, 2007. ISBN 978-3-8351-9203-4 • Kruse et al.: “Computational Intelligence - A Methodological Introduction”, Springer, 2013. ISBN 978-1-4471-5012-1 • Kruse et al.: “Computational Intelligence [DE]”, Vieweg+Teubner-Verlag, Wiesbaden, 2011. ISBN 978-3-8348-1275-9 • Wang et al.: “Electronic Design Automation”, Morgan Kaufmann, 2009. ISBN: 0-1237-4364-8
Comments
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4.32 Mobile Communications

Course	Mobilkommunikation
Coordination	Prof. Dr. Holger Karl
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://wwwcs.upb.de/cs/cn/`
Intended semester	Winter term
Modules using this course	Mobile Networks (S. 37)
Short description	
The lecture discusses foundations of mobile communication (e.g., wireless channel models) and fundamental techniques (e.g., spread spectrum communication), important protocol mechanisms (e.g., medium access in wireless systems), mobile communication systems, and MobileIP. In addition to technological and conceptual aspects, we shall also discuss approaches and methods for performance evaluation of mobile communication systems.	
Content	
• Basics and physical layer: channel models, fading, Rayleigh channel, modulation, OFDM, spread spectrum • Medium access control: Aloha in Rayleigh channels, CSMA, hidden terminal, RTS/CTS, busy-tone protocols • Cellular systems: GSM, UMTS, LTE, focusing on system architecture • Wireless LAN systems: IEEE 802.11, medium access, power control, energy efficiency, Bianchi's performance analysis • Mobility in fixed networks: Mobile IP and related approaches	
Learning objectives, competences	
Participants of this class know challenges and problems arising in design and operation of mobile communication systems. They can differentiate between challenges based in physics and those arising from a particular system design; they can choose suitable protocols or design new ones. They are able to select mechanisms from different architectural layers, integrate them into a new complete architecture and justify their selection and integration decisions. They are also able to quantitatively evaluate protocol mechanisms.	
Implementation	
Lecture with slides and blackboard; homework assignments.	
Recommended knowledge	
Basic knowledge of computer networks is required, e.g., a Bachelor-level class "Computer networks".	
Assessment modalitites	
Oral exam	
Teaching Material, literature	

Slide set; chapters from various textbooks (J. Schiller, Mobile Communication, Addison Wesley, 2nd edition; D. Tse und P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005).
Comments
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4.33 Model-Driven Software Development

Course	Model-Driven Software Development
Coordination	Prof. Dr. Wilhelm Schäfer
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/fachgebiet-softwaretechnik.html`
Intended semester	Winter term
Modules using this course	SW-Engineering for Embedded Systems (S. 66)
Short description	
Model-driven software development aims at the development of software solely based on models. Ideally, the final system is completely generated and analysed based on the model. The lecture Model-Driven Software Development introduces in details methods and processes for model-driven development.	
Content	
(Software)-Models, meta-models, model transformations, model-driven software development processes, testing in model-driven software development	
Learning objectives, competences	
Complete software modelling, Creation of own software modelling languages, Transforming software models in code, Integration of model-driven approaches in development processes, Testing of models and metamodels, Using modern transformation languages	
Implementation	
Lecture with Beamer, Lab exercises	
Recommended knowledge	
Model-Based Software Development M	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
T. Stahl, M. Völter, Model-Driven Software Development, Wiley	
Comments	
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4.34 Modellbildung, Identifikation und Simulation

Course	Modellbildung, Identifikation und Simulation
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Modellbildung, Identifikation und Simulation (S. 79)
Short description	
Basics of analytic and computer-based design of mathematic models and their treatment in numeric simulation.	
Content	
Experimental-based model construction. Analytic model construction. Numeric solution of differential equations.	
Learning objectives, competences	
Students can compute parameters of a transfer function out of measured data. They can analytically determine mathematical models, in particular, using computer algebra tools. They can choose and evaluation suitable techniques to numerically solve differential equations.	
Implementation	
Lectures using blackboard; homework assignments; some computer-based demonstrations.	
Recommended knowledge	
Some knowledge of system theory and control theory are helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.35 Optical Communication A

Course	Optische Nachrichtentechnik A
Coordination	Prof. Dr.-Ing. Reinhold Noe
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ont.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Optical Communication A (S. 40)

Short description

The course "Optical Communications A" introduces into modern optical communications on which internet and telephony rely. This lecture will impart also knowledge on ultra-broadband communication systems. Every optical waveguide is about 1000 times as broadband as most efficient microwave communication satellites. Optical transmission can be explained by the wave model whereas effects like emission, absorption and amplification of photons are modeled by the particle aspect. This dualism and basic knowledge of communications and electronics lead to an understanding of optical communications. Wavelength multiplex has an eminent importance because of it's high capacity beyond 10Tbit/s or transoceanic spans.

Content

Optical Communications A:

This course explains the wave propagation by Maxwell?s equations as well as terms as polarization and wave guiding by dielectric parallel waveguides and cylindrical waveguides as optical fibers. Furthermore, items as dispersion are explained and their effects on transmission. Beyond this, components like lasers, photodiodes, optical amplifiers and optical receivers and regenerators will be dealt with as well as modulation and signal formats like wavelength multiplex as an effective technique for broadband transmission. In this lecture, the most important contexts will be given.

Learning objectives, competences

After attending the course, the students will be able to
- describe, model and apply the function of components, systems and effects of optical communications and
- apply knowledge of optoelectronics.

The students
- are able to apply the knowledge and skills to a wide range of disciplines,
- are able to make use of a methodical procedure when undertaking systematic analysis and
- are, due to the abstract and precise treatment of the contents, in a position to continue and develop their learning themselves.

Implementation
• Lectures using presentations via transparencies, • Exercise classes with exercise sheets and demonstrations on computer.
Recommended knowledge
Higher Mathematics, Physics, and the Foundations of Electrical Engineering.
Assessment modalitites
Oral exam
Teaching Material, literature
R. Noé, Essentials of Modern Optical Fiber Communication, Springer-Verlag, 2010 Scriptum for a major part of the lectures Optical Communications A, B, C, D as well an Optical Transmission Technology, English only
Comments
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4.36 Optical Communication B

Course	Optische Nachrichtentechnik B
Coordination	Prof. Dr.-Ing. Reinhold Noe
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ont.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Optical Communication B (S. 41)
Short description	
The course “Optical Communications B” gives an introduction into mode coupling in optical communications. A mode is a wave which has a unique propagation constant at a given frequency. In case of mode coupling, there is a power exchange between different modes, which happens according to the setup in co- or contradirectional way. In this course, there are mechanisms and applications explained.	
Content	
Optical Communications B: This course deals with terms as polarization mode dispersion (PMD) orthogonal modes, constant and periodic co- and contradirectional mode coupling, profiles of polarization mode dispersion and electrooptical effect. The function of various active and passive optical components can be explained like amplitude and phase modulators, broadband and wavelength-selective couplers, Bragg gratings, polarization maintaining fibers, polarization transformers and compensators for polarization mode dispersion and chromatic dispersion.	
Learning objectives, competences	
After attending the course, the students will be able to • understand the meaning and importance of wave modes and mode coupling in optical communications, • make up and understand mathematical models of optical components and systems and • understand and abstract how optical components work The students • are able to apply the knowledge and skills to a wide range of disciplines, • are able to make use of a methodical procedure when undertaking systematic analysis and • are, due to the abstract and precise treatment of the contents, in a position to continue and develop their learning themselves.	

Implementation
• Lectures using presentations via transparencies, • Exercise classes with exercise sheets and demonstrations on computer.
Recommended knowledge
Higher Mathematics, Physics, and the Foundations of Electrical Engineering. Optical Communications A recommended.
Assessment modalitites
Oral exam
Teaching Material, literature
R. Noé, Essentials of Modern Optical Fiber Communication, Springer-Verlag, 2010 Scriptum for a major part of the lectures Optical Communications A, B, C, D as well an Optical Transmission Technology, English only
Comments
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4.37 Optical Communication C

Course	Optische Nachrichtentechnik C
Coordination	Prof. Dr.-Ing. Reinhold Noe
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ont.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Optical Communication C (S. 42)
Short description	
The course "Optical Communications C" has the subject of modulation formats. Besides the classical On/Off-keying (OOK), there are different ways to modulate an optical signal either to improve the signal to noise ratio or to transmit more than one bit per symbol as quarternary modulation (four signal states) or polarization mode multiplex. In this lecture, also advanced modu-lation formats are treated.	
Content	
Optical Communications C: Noise in optical systems using amplifiers, data transmission with binary and quaternary phase shift keying and optical amplifiers, polarization multiplex, coherent optical data transmission, synchronous and asynchronous demodulation, coherent baseband receivers, polarization diversity, electronic compensation of optical distortions like electronic polarization control and electronic compensation of polarization mode dispersion and chro-matic dispersion, phase noise, further modulation schemes. Advanced modulation schemes represent a chance for further development of efficient optical communication systems.	
Learning objectives, competences	
After attending the course, the students will be able to • know and evaluate different modulation schemes in Optical Communications in their meaning, • see the importance of efficient modulation schemes in Optical Communications and • realize and develop efficient optical communication systems. The students • are able to apply the knowledge and skills to a wide range of disciplines, • are able to make use of a methodical procedure when undertaking systematic analysis and • are, due to the abstract and precise treatment of the contents, in a position to continue and develop their learning themselves.	

Implementation
• Lectures using presentations via transparencencies, or directly on the computer • Exercise classes with exercise sheets and demonstrations on computer.
Recommended knowledge
Higher Mathematics, Physics, and the Foundations of Electrical Engineering. Optical Communications A recommended.
Assessment modalitites
Oral exam
Teaching Material, literature
R. Noé, Essentials of Modern Optical Fiber Communication, Springer-Verlag, 2010 Scriptum for a major part of the lectures Optical Communications A, B, C, D as well an Optical Transmission Technology, English only
Comments
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4.38 Optimale Systeme

Course	Optimale Systeme
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Optimale Systeme (S. 80)
Short description	
Methods to design optimal control systems for non-linear processes, based on variational calculus.	
Content	
Basics of variational calculus, derive theoretic approaches to solve optimal control problems. Lagrange function and Hamilton formalism. Special cases: Riccati control; Kalman filter; Pontryagin maximization.	
Learning objectives, competences	
Students can use variational calculus for optimal control of a dynamic system; evaluate the suitability of a figure of merit criterion for a given problem; solve Riccati control and Kalman filter problems for simple non-linear systems.	
Implementation	
Lecture using blackboard; homework assignments; some demonstration using computers.	
Recommended knowledge	
Some knowledge of control theory is helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.39 Optimale und adaptive Filter

Course	Optimale und adaptive Filter
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Winter term
Modules using this course	Optimale und adaptive Filter (S. 43)

Short description

The course “Optimal and adaptive filters” gives an introduction to the basic techniques and theories of adaptive filters. Based upon the basics of estimation theory optimal filters are discussed. Subsequently the topics Wiener filter theory, deterministic optimization under constraints and stochastic gradient methods are regarded. Concluding the Least Squares approach for solving filter tasks and the Kalman filter are introduced. The latter is regarded as a brief introduction to state based filters.

Content

- Classic parameter estimation: Estimators, MMSE-Estimation, Linear estimators, Orthogonality principle, Evaluation of estimators
- Wiener filter: Wiener-Hopf equation, AR- and MA processes, Linear prediction
- Iterative optimization methods: Gradient ascent/descent, Newton method
- Linear adaptive filters: LMS algorithm, Least-Squares method, Blockwise and recursive adaptiv filters, Realization aspects
- Statemodel based filters: Kalman filter
- Applications: System identification, Channel estimation and equalization, Multi-channel speech signal processing, Noise and interference suppression

Learning objectives, competences

After attending the course, the students will be able to
- analyze tasks in the field of adaptive filters and to formulate requirements mathematically,
- develop filter using cost functions and
- implement selected adaptive filters in the frequency or time domain.

The students
- are able to check theoretical results using practical realizations,
- are able to undertake theoretical approaches a systematic analysis using methodical procedures and
- are, due to the precise treatment of the contents, in a position to continue their learning themselves

Implementation
• Lectures using the blackboard and presentations, • Alternating theoretical and practical exercise classes with exercise sheets and computer and • Demonstration of real technical systems in the lecture hall.
Recommended knowledge
Prior knowledge from the modules Higher Mathematics and Digital Signal Processing is helpful.
Assessment modalitites
Oral exam
Teaching Material, literature
Allocation of a script; information on textbooks; matlab scripts
Comments
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4.40 Optische Messverfahren

Course	Optische Messverfahren
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Winter term
Modules using this course	Optische Messverfahren (S. 57)

Short description

Laser-Doppler Anemometry; Speckle interferometry; FTIR and spectroscopic schemes.

Content

- Sources of rays
- Interaction with media, absorption, tranmission
- Ray detection
- Fourier optics
- Performance evaluation
- Simulation complex systems
- Spectroscopic measurements
- Applications: colorometry, NIR

Learning objectives, competences

Students can analyse and evaluate complex tasks in optical measurements and design their own solutions. They can ascertain applications regarding their actual requirements and properties with respect to optical measurement techniques.

Implementation

Lectures with interactive whiteboards, homework assignments, lab experiments in small groups, presentations and discussions lead by individual students.

Recommended knowledge

None

Assessment modalitites

Oral exam

Teaching Material, literature

Supplementary material and textbooks.

Comments

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4.41 Processing, Indexing, and Compression of Structured Data

Course	Processing, Indexing, and Compression of Structured Data
Coordination	Prof. Dr. Stefan Böttcher
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/ag-boettcher/lehre.html`
Intended semester	Winter term
Modules using this course	Large-scale IT systems (S. 49)
Short description	
Processing, indexing and compressing structured and semi-structured data, in particular XML.	
Content	
• XML axes, XML schema, XML parser, XML relational mapping • XML data bases (XPath, XQuery, XQuery Update Facility, SQL/XML), • XML streaming and looking forward transformations, • XML coding and compression (succinct coding, DAG, repair, schema subtraction, XBW, . . .) • numbering schemes (OrdPath, Dynamic Dewey, ...), • XML keyword search	
Learning objectives, competences	
Students can comprehend, design, implement and assess (with respect to time and space complexity) XML processing in software systems. They known pivotal search and query techniques to acquire information in uncompressed and compressed XML data. They can appropriately process infinite data streams. They can acquire new research results from scientific publications.	
Implementation	
Lecture using slides; practical exercises using computers.	
Recommended knowledge	
XML syntax, searching in trees and graphs, programming in Java.	
Assessment modalitites	
One oral or one written exam determines module grade	
Teaching Material, literature	
Slides as script; scientific publications.	
Comments	
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4.42 Quantitative Evaluation of Software Designs

Course	Quantitative Evaluation of Software Designs
Coordination	Jun.-Prof. Dr. Steffen Becker
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.hni.uni-paderborn.de/swt/mitarbeiter/130148509900101/`
Intended semester	Summer term
Modules using this course	SW-Engineering for Embedded Systems (S. 66)
Short description	
Besides functional correctness, software also has to fulfil non-functional properties, e.g., performance, scalability or reliability. They have to be systematically considered in the software design. The lecture introduces methods and tools to specify and analyse software quality attributes already during design time without having an underlying implementation.	
Content	
Software models and quality annotations, transformation of software models into analysis models for performance and reliability, Markov chains for software modelling, queuing networks, architecture tradeoff analysis	
Learning objectives, competences	
Modelling of non-functional properties of software using MARTE or specialised DSLs, Transforming software designs into analysis models, Interpreting analysis results, Balancing software qualities which conflict with each other, Using modelling and analysis tools	
Implementation	
Lecture with Beamer, Lab exercises	
Recommended knowledge	
Model-Based Software Development	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Bolch, Greiner, de Meer, Trivedi, Queueing Networks and Markov Chains. Jain, The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling	
Comments	
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4.43 Reconfigurable Computing

Course	Reconfigurable Computing
Coordination	Prof. Dr. Marco Platzner
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://www.cs.uni-paderborn.de/fachgebiete/computer-engineering-group/`
Intended semester	Winter term
Modules using this course	Clouds, Grids, and HPC (S. 36), Computer Architecture (S. 47), Real-time/Embedded Systems (S. 65)
Short description	
This lecture provides an understanding of architectures and design methods for reconfigurable hardware systems and presents applications in the areas of high performance computing and embedded systems.	
Content	
• Introduction: evolution of programmable logic devices, market economics • Architectures: FPGA architectures, reconfigurable devices, reconfigurable systems • Design methods: CAD for FPGAs, high-level languages and compilers, system-level design • Applications: custom computing machines, embedded systems	
Learning objectives, competences	
After attending the course, the students • are able to explain the architectures of reconfigurable hardware devices, • to name and analyze the main design methods and • to judge the suitability of reconfigurable hardware for different application domains.	
Implementation	
Lecture with beamer and blackboard; interactive exercises; tutorials.	
Recommended knowledge	
Basic knowledge in computer architecture	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
• Lecture slides, exercise sheets • Selected papers	
Comments	
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4.44 Regelungstechnik B

Course	Regelungstechnik B
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Regelungstechnik B (S. 58)
Short description	
The lecture prepares students for the multitude of feedback-based control structures. Limitations in set point control lead to control dynamics. Based design schemes for control loops are discussed.	
Content	
Single loop control with extended structure; multi-loop structure; state-based control; multi-variable control. Mathematical modeling and analysis of non-linear processes, design of controls.	
Learning objectives, competences	
Students can compare different feedback structures and dimension them according to a task's requirements; analyse the dynamic behavior of a feedback system under limited set points; design control loops with these limitations in mind.	
Implementation	
Lectures with blackboard; homework assignments; some demonstrations based on computer.	
Recommended knowledge	
Some knowledge of control theory is helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.45 Regelungstheorie - Nichtlineare Regelungen

Course	Regelungstheorie - Nichtlineare Regelungen
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Regelungstheorie - Nichtlineare Regelungen (S. 59)
Short description	
Theoretical aspects of non-linear systems in descriptor representation; emphasis on techniques relevant for automation tasks. Design of feedback for exact linearization, de-coupling input/output behavior.	
Content	
Exact linearization based on diffential-geometric methods. Non-linear systems that are affine in their inputs. Resulting de-coupling. Extension to multi-variable control in descriptor representation.	
Learning objectives, competences	
Students can describe basics of differential-geometric methods; explain mathematic models of non-linear systems in state and descriptor representation; apply those techniques to solve challenging control theoretic problems.	
Implementation	
Lectures with blackboard; homework assignments; some demonstrations based on computer.	
Recommended knowledge	
Some knowledge of system and control theory is helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.46 Robotics

Course	Robotik
Coordination	Prof. Dr. Bärbel Mertsching
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://getwww.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Robotics (S. 60)

Short description

The course “Robotics” introduces basic concepts and techniques in the field of mobile robotics. The challenges for the development of autonomous intelligent systems will be analyzed and the current solutions will be presented.

Content

In detail the following topics are covered:
- Sensors, effectors, actuators
- Homogenous coordinates, general transformations, Denavit-Hartenberg parameters
- Kinematics and dynamics of robot arms and mobile robots

Learning objectives, competences

The students
- know how to transfer basic methods from control and system theory to robotics and
- are able to apply the adequate methods to describe as well as plan and control the movements of robot arms and mobile robots.

Furthermore, they are able to identify and evaluate the function and behavior of robots and their integration into the social and economic environment while also considering ethical aspects.

Implementation

- The theoretical and methodical fundamentals will be introduced during the lecture.
- The methods presented will be practiced during the subsequent exercise / lab part.
- Finally, the participants will implement, test, and apply simple algorithms.
- The necessary programming skills will be taught during the practical, this is explicitly not considered a programming course.

Recommended knowledge

None

Assessment modalitites

Oral exam

Teaching Material, literature

Allocation of lecture notes; information on textbooks stocked in the textbook collection will be announced later.
- Mertsching, Bärbel: Robotics (lecture notes)
- McKerrow, Phillip J.: Introduction to Robotics. Addison-Wesley, 1991
- Siegwart, Roland; Nourbakhsh, Illah R. and Scaramuzza, David: Introduction to Autonomous Mobile Robots. The MIT Press, 2011, ISBN-13: 978-0262015356

Comments

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4.47 Routing and Data Management in Networks

Course	Routing and Data Management in Networks
Coordination	Prof. Dr. Friedhelm Meyer auf der Heide
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	http://www.hni.uni-paderborn.de/en/algorithms-and-complexity/
Intended semester	Winter term
Modules using this course	Networking Theory (S. 39), Clouds, Grids, and HPC (S. 36)
Short description	
Routing and data management are basic tasks to efficiently use large networks like the Internet, peer-to-peer networks or mobile ad hoc networks. This lecture treats algorithms and their analysis for these tasks in such systems. Special emphasis is on dynamics (movement, adding and deleting nodes).	
Content	
• Online routing in multi-butterfly networks • Deterministic and randomized protocols for oblivious routing • Facility location • Page migration and other data managements schemes for static and dynamic networks	
Learning objectives, competences	
Students will be able to design and evolve schemes for routing and data management in networks. They can evaluate and appraise such schemes with respect to suitability and efficiency in various application scenarios.	
Implementation	
Lecture with home assignments.	
Recommended knowledge	
Basics of graph theory, combinatorics and stochastic, algorithm design and analysis.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Slides and script; additional literature recommended during the lecture.	
Comments	
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4.48 Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik

Course	Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik
Coordination	Prof. Dr.-Ing. Christoph Scheytt
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www.hni.uni-paderborn.de/sct/`
Intended semester	Winter term
Modules using this course	Schnelle integrierte Schaltungen für die digitale Kommunikationstechnik (S. 64)

Short description

In modern fiber-optic communication systems data rates of several 100 Gb/s per optical channel and several Tb/s per fiber are transmitted. In a similar way nowadays the data transmission between electronic chips reaches data rates of more than 10 Gb/s over a single package pin which has to be transmitted over low-cost serial cable and printed circuit boards. In the future the progress in digital CMOS technologies these data rates will be continuously increased. Goal of the lecture is to convey a methodical design process of fast integrated electronic circuits for digital wireline communications.

Content

The following topics will be addressed:
- Transmitter and receiver architectures for fiber-optic communications
- Transmitter and receiver architectures for chip-to-chip communications
- System Theory of digital links: Digital signals in time and frequency domain, Transmit behaviour of bandwidth limited linear systems, Signal degeneration (ISI, jitter, noise)
- Semiconductor technologies and integrated high-frequency devices
- Ampfliers
- Current-mode logic (CML)
- Transmitter and receiver circuits
- PLL-technique for frequency synthesis and clock recovery

Learning objectives, competences
The students will be able • to describe architectures and circuits of fast digital data transmission links, • to describe and calculate fundamental signal transmission properties of digital systems, • to apply design methods to design basic integrated broadband circuits. The students can • present their knowledge to a professional audience, • combine the abstract mathematical analysis, numerical simulation, and circuit design, • apply system analysis and circuit design in a methodical approach.
Implementation
• Powerpoint and Whiteboard • Mathematical exercises and design exercises with modern IC design software
Recommended knowledge
Schaltungstechnik
Assessment modalitites
Oral exam
Teaching Material, literature
Lecture and exercise slides, Literature • Paul Gray et al. “Analysis And Design of Analog Integrated Circuits”, Wiley & Sons 2001 • Eduard Säckinger “Broadband Circuits for Optical Fiber Communication”, Wiley & Sons 2005 • Behzad Razavi “Design of ICs for Optical Communications”, McGraw-Hill, 2003
Comments
As part of the lecture it is planned to offer a 2-day excursion to IHP Leibnizinstitut für Innovative Mikroelektronik in Frankfurt (Oder).

4.49 Software Quality Assurance

Course	Software Quality Assurance
Coordination	Prof. Dr. Gregor Engels
Teaching Unit	Department of Computer Science
Language	English
Type	2 SWS VL, 1 SWS UE
Work load	• 30 h contact hours lectures • 15 h contact hours exercises • 75 h self-study **120 h total workload**
Course homepage	`http://is.uni-paderborn.de/en/research-group/fg-engels/home.html`
Intended semester	Summer term
Modules using this course	SW-Engineering for Embedded Systems (S. 66)
Short description	
The aim of the lecture is to cover standards, methods, processes, technologies and strategies related to quality assurance for software systems. These include on the one hand constructive approaches which are used during the development of software systems, and on the other hand analytic approaches which are used to check the quality of existing software systems.	
Content	
• Basics / Definitions – software quality, metrics • Standards – ISO 9001, ISO 9126, CMM-I, ISTQB • Constructive Approaches – patterns, anti-patterns, architectural styles, model-driven development, domain-specific languages, process patterns, consistency constraints • Analytical Approaches – inspection and review techniques & testing: black-box, white-box, coverage criteria, fundamental test process, model-based testing	
Learning objectives, competences	
Students should be able to list and to describe relevant software qualities and their interdependencies. They should be able to select and to apply the right constructive techniques in order to ensure a high quality of a software system. They should also be able to apply standard analytic techniques to check the degree of quality of a given software systems.	
Implementation	
Lecture supported by slides and blackboard, exercises, self-study	
Recommended knowledge	
Programming Skills, Software Modeling (particularly UML) Skills, Software Process Models	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Daniel Galin: Software Quality Assurance: From theory to implementation, Addison Wesley 2004	
Comments	
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4.50 Statistische Lernverfahren und Mustererkennung

Course	Statistische Lernverfahren und Mustererkennung
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Summer term
Modules using this course	Statistische Lernverfahren und Mustererkennung (S. 81)

Short description

The course on "Statistical Learning and Pattern Recognition" presents an introduction into the components and algorithms prevalent in statistical pattern recognition. Both parametric and non-parametric density estimation and classification techniques will be presented, as well as supervised and unsupervised learning paradigms. The presented techniques can be applied to a variety of classification problems, both for one-dimensional input data (e.g., speech), two-dimensional (e.g., image) or symbolic input data (e.g., documents).

Content

- Elements of a pattern classifier
- Decision rules: Bayesian decision rule, k-nearest neighbor rule
- Maximum Likelihood parameter estimation, Bayesian learning, nonparametric density estimation
- Dimensionality reduction: the curse of dimensionality, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA)
- Linear classifiers: linear discriminants, Support Vector Machines
- Artificial neural networks
- Unsupervised learning: mixture density estimation, cluster analysis
- Algorithm-independent considerations: Bias/Variance dilemma, model complexity, Bayesian Information Criterion

Learning objectives, competences

After completion of the course students will be able to
- Choose an appropriate decision rule for a given classification problem
- Apply supervised or unsupervised learning techniques to data of various kinds and critically assess the outcome of the learning algorithms
- Work with dedicated pattern classification software (e.g., for artificial neural networks, support vector machines) on given data sets and optimize parameter settings
- Find, for a given training set size, an appropriate choice of classifier complexity and feature vector dimensionality

The students • Have gathered sufficient proficiency in Matlab, well beyond what is needed to realize pattern classification techniques • Can assess the importance of the principle of parsimony and are able to transfer it to other • Are able to apply the knowledge and skills learnt in this course to a wide range of disciplines • Can work cooperatively in a team and subdivide an overall task into manageable subtasks and work packages
Implementation
• Lectures predominantly using the blackboard or overhead projector, occasional presentations of (powerpoint) slides, • Exercise classes with exercise sheets and demonstrations on computer and • Implementation of learning and classification algorithms on a computer by the students themselves; use of algorithms on real-world data or data generated on the computer, evaluation of the simulation results
Recommended knowledge
Elementary knowledge in statistics, as is taught in the course Statistical Signal Processing, is helpful.
Assessment modalitites
Oral exam
Teaching Material, literature
Course script and summary slides are provided tot he students. Exercises and solutions to exercises, as well as sample implementations of algorithms are provided to the students. Further literature • R.O. Duda, P.E. Hart, D.G.˜ Stork, Pattern Classification, Wiley, 2001 • K. Fukunaga, Introduction to Statistical Pattern Recognition, Academic Press, 1990
Comments
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4.51 Systemtheorie - Nichtlineare Systeme

Course	Systemtheorie - Nichtlineare Systeme
Coordination	Prof. Dr. techn. Felix Gausch
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www-control.uni-paderborn.de/`
Intended semester	Summer term
Modules using this course	Systemtheorie - Nichtlineare Systeme (S. 82)
Short description	
Stability of non-linear dynamic systems, Lyapunov stability theory, application to feedback control.	
Content	
Comparison of linear and non-linear dynamics; spectral shape of output; stability. Stability based on Lyapunov theory; construction of these functions. Stability investigations.	
Learning objectives, competences	
Students can classify differences between linear and non-linear systems; systematic determine stable states; apply analytic techniques to the design of feedback controls.	
Implementation	
Lectures with blackboard; homework assignments; some demonstrations based on computer.	
Recommended knowledge	
Some knowledge of system and control theory is helpful.	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.52 Technische kognitive Systeme

Course	Technische kognitive Systeme
Coordination	Prof. Dr. Bärbel Mertsching
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://getwww.uni-paderborn.de/`
Intended semester	Winter term and Summer term
Modules using this course	Technische kognitive System (S. 83)
Short description	
Text folgt noch	
Content	
Text folgt noch	
Learning objectives, competences	
Text folgt noch	
Implementation	
Text folgt noch	
Recommended knowledge	
Text folgt noch	
Assessment modalitites	
Text folgt noch	
Teaching Material, literature	
Text folgt noch	
Comments	
Text folgt noch	

4.53 Technologie hochintegrierter Schaltungen

Course	Technologie hochintegrierter Schaltungen
Coordination	Prof. Dr.-Ing. Ulrich Hilleringmann
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sensorik.uni-paderborn.de/`
Intended semester	Winter term
Modules using this course	Technologie hochintegrierter Schaltungen (S. 71)

Short description

The course “Technology of highly integrated circuits” focuses on very large-scale integration of semiconductor devices. Starting from standard CMOS-Processing, problems of increasing the integration density and their solutions will be discussed. Here the Local Oxidation of Silicon, Silicon on Insulator and process steps for very large-scale integration are explained. Subsequently integration techniques for bipolar transistors are illustrated.

Content

In detail the following topics are covered:
- Local Oxidation of Silicon
- MOS-Transistors for very large-scale integration
- SOI-Technology
- Integration of Bipolar Transistors
- Nano Scale Transistors
- Other Transistor concepts

Learning objectives, competences

After attending the course, the students will be able t0
- choose Local Oxidation of Silicon method for integration of transistors and calculate layer thicknesses
- explain the integration of nano-scale transistors
- explain transistor manufracturing with SOI-Technology.
- develop processes for circuits with bipolar transistors.
- explain circuits in BiCMOS-Technology.

The students
- are able to apply the practiced strategies for problem solving across varying disciplines,
- have experience in presenting their solutions to their fellow students, and
- know how to improve their competences by private study.

Implementation
• Lecture based on slide presentation, extensions on blackboard • Exercises in small groups based on exercise sheets with students presenting their own solutions
Recommended knowledge
Werkstoffe der Elektrotechnik, Halbleiterbauelemente, Halbleiterprozesstechnik
Assessment modalitites
Oral exam
Teaching Material, literature
• Handouts of lecture slides • Hilleringmann, U.: Silizium-Halbleitertechnologie, Teubner Verlag • Additional links to books and other material available at the webpage
Comments
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4.54 Test hochintegrierter Schaltungen

Course	VLSI Testing
Coordination	Prof. Dr.-Ing. Sybille Hellebrand
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://www.date.uni-paderborn.de/en/willkommen/`
Intended semester	Winter term
Modules using this course	Test hochintegrierter Schaltungen (S. 67)

Short description

The course "VLSI Testing" focuses on techniques for detecting hardware defects in micro-electronic circuits. Algorithms for test data generation and test response evaluation as well as hardware structures for design for test (DFT) and on-chip test implementation (BIST) are presented.

Content

In detail the following topics are covered:
- Fault models
- Testability measures and design for test (DFT)
- Logic and fault simulation
- Automatic test pattern generation (ATPG)
- Built-in self-test (BIST), in particular test data compression and test response compaction
- Memory test

Learning objectives, competences

After attending the course, the students will be able
- to describe fault models, DFT techniques, and test tools,
- to explain and apply the underlying models and algorithms for fault simulation and test generation,
- to analyze systems with respect to their testability and to derive appropriate test strategies.

The students
- are able to apply the practiced strategies for problem solving across varying disciplines,
- have experience in presenting their solutions to their fellow students, and
- know how to improve their competences by private study.

Implementation

- Lecture based on slide presentation, extensions on blackboard
- Exercises in small groups based on exercise sheets with students presenting their own solutions
- Hands-on exercises using various software tools

Recommended knowledge
Introduction to Computer Engineering
Assessment modalitites
Oral exam
Teaching Material, literature
• Handouts of lecture slides • M. L. Bushnell, V. D. Agrawal, Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits, Boston, Dordrecht, London: Kluwer Academic Publishers, 2000 • L.-T. Wang, C.-W. Wu, X. Wen, VLSI Test Principles and Architectures: Design for Testability, Morgan Kaufmann Series in Systems on Silicon, ISBN: 0123705975 • Additional links to books and other material available at the webpage
Comments
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4.55 Topics in Pattern Recognition and Machine Learning

Course	Aktuelle Themen aus Mustererkennung und maschinellem Lernen
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Winter term and Summer term
Modules using this course	Topics in Pattern Recognition and Machine Learning (S. 84)

Short description

The course on "Topics in Pattern Recognition and Machine Learning" first briefly summarizes the main concepts of statistical pattern recognition and machine learning. Next selected topics will be presented in detail. The choice of topics depends on current research activities and thus may change over time. Examples of such topics to be studied in detail include

- Model estimation in the presence of hidden variables, in order to reveal suspected latent structure buried in the data
- Bias-Variance dilemma and the tradeoff between degree of detail and generalizability of models
- Grafical models
- Sequential data and hidden Markov models
- Specific classification tasks, such as automatic speech recognition

While the first part of the course will follow a regular lecture format, the second part will include active student participation. Students will be asked to read, analyze and present recently published papers from the pattern recognition and machine learning literature. This will often also include the implementation of proposed algorithms in Matlab.

Content

- Fundamentals of statistical pattern recognition: Bayes rule, learning of class-conditional densities, linear models for classification and regression
- EM Algorithm and extensions thereof
- Models with discrete or continuous latent variables; GMM, NMF
- Bias-Variance dilemma and model selection
- Graphical models
- Hidden Markov models and their application in speech recognition
- Recent publications in pattern recognition and machine learning

Learning objectives, competences
After completion of the course students will be able to • Choose an appropriate classifier for a given classification problem and be able to learn the parameters of the classifier from training data • Choose an appropriate regression method for function approximation and learn its parameters from training data • Search for latent variables and structure in given data • Make an informative choice for the model order to find a good compromise between degree of detail and generalizabliliy • Comprehend and analyze recent publications from the field of pattern recognition and machine learning The students • Have gathered an understanding of the importance of the chosen model order on the outcome of classification and regression tasks • Are aware of the impact of a priori assumptions on the result of latent variable and structure discovery in data • Are able to autonomously gain expertise in a certain field of pattern recognition by conducting a literature survey • Can gauge the importance of a given publication for the state of the art in a field • Are able to apply the knowledge and skills learnt in this course to a wide range of disciplines
Implementation
• Lectures predominantly using the blackboard or overhead projector, occasional presentations of (powerpoint) slides, • Exercise classes with exercise sheets and demonstrations on computer • Instructions how to read and analyze scientific publications in this field • Autonomous analysis of publications and presentation of results and gained insight
Recommended knowledge
Elementary knowledge in Probability Theroy, as is taught in the course Statistical Signal Processing. Desirable, but not mandatory: knowledge in the field of statistical learning and pattern recognition
Assessment modalitites
Oral exam
Teaching Material, literature
Literature • R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification, Wiley, 2001 • K. Fukunaga, Introduction to Statistical Pattern Recognition, Academic Press, 1990 • C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
Comments
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4.56 Topics in Signal Processing

Course	Topics in Signal Processing
Coordination	Prof. Peter Schreier, PhD
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://sst.uni-paderborn.de/`
Intended semester	Winter term and Summer term
Modules using this course	Topics in Signal Processing (S. 85)
Short description	
This course covers a selection of current topics in signal processing. One part of this course will follow a regular lecture format, while the other part will require active student participation.	
Content	
This course will first review relevant aspects of linear algebra and probability theory. Then students will learn how to read, analyze, and present recent papers from the signal processing literature.	
Learning objectives, competences	
In this course, students will familiarize themselves with some current research topics in signal processing. They will learn to read and understand scientific publications and to critically evaluate results. Students will develop confidence in their ability to solve mathematical problems of analysis and design. They will be able to apply the principles they have learnt in this course to other areas.	
Implementation	
• Lecture with active student participation • Student presentations	
Recommended knowledge	
Signal and system theory, at least a basic understanding of probability and linear algebra	
Assessment modalitites	
1 seminar paper (oral presentation and written report)	
Teaching Material, literature	
References will be given during first lecture.	
Comments	
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4.57 Ultraschall-Messtechnik

Course	Ultraschall-Messtechnik
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Summer term
Modules using this course	Ultraschall-Messtechnik (S. 61)

Short description

Mechanical waves in solids, fluids, gases. Main acoustic measurement principles. Applications for ultrasound tomography.

Content

- Acoustics and sound waves
- Basics of wave propagation
- Design of ultra sound sensors
- Methods to measure ultrasound fields and acoustics material investigation

Learning objectives, competences

Students can use ultrasound to determine acoustic and non-acoustic parameters.

Implementation

Lectures with slides; practical work in small groups.

Recommended knowledge

None

Assessment modalitites

Oral exam

Teaching Material, literature

Script and textbooks.

Comments

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4.58 Umweltmesstechnik

Course	Umweltmesstechnik
Coordination	Prof. Dr.-Ing. Bernd Henning
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://emt.uni-paderborn.de/index.php?id=8616&L=2`
Intended semester	Winter term
Modules using this course	Umweltmesstechnik (S. 62)
Short description	
Measuring the environment.	
Content	
• legal aspects of environmental protection • Relevance of measurement techniques • Chemo sensors • Measurement principles in environmental techniques • Optoden and optical techniques • Sensors for fluids and gases	
Learning objectives, competences	
Students understand measurement problems in the context of environmental protection, can choose suitable measurement techniques, and characterize and interpret their measurement results.	
Implementation	
• Vorlesungen mit Folien-Präsentation umfangreicher Zusammenhänge • Praktische Arbeit in Gruppen mit Messtechnik im Labor Lecture with slides; practical work in small groups.	
Recommended knowledge	
None	
Assessment modalitites	
Oral exam	
Teaching Material, literature	
Script and textbooks.	
Comments	
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4.59 Videotechnik

Course	Videotechnik
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Summer term
Modules using this course	Videotechnik (S. 87)

Short description

The course "Video Technology" gives an introduction to the basic techniques and theories of taking , processing and reproduction of motion pictures and transmitting them via analogue and digital links. Starting with the basics of scanning necessary bandwidth and standards of intended systems are discussed. Depending on the colour vision system of the human eye science of colour and analogue and digital colour coding are described.

Electronic camera systems and modern reproduction sets complements the theory.

Digital picture transmission systems combined with data reduction (MPEG) are the main emphasis of modern transmission like DVB (Digital Video Broadcasting).

Video tape recording (VTR), optical (DVD) and electrical picture storing systems are described. New 3 dimensional picture taking and viewing will be shown.

Content

- Colour vision System; Basic Principles of Colour
- Basics of Picture Scanning
- Video Signal, Standards, Basics of Colour Video Techniques
- Electronic Cameras, Digitization
- Sourcecoding, Picture Data Reduction Systems
- Channelcoding and Transmission, Digital Transmission (MPEG)
- Receivers and Storage
- 3-D Technology

Learning objectives, competences

After attending the course, the students will be able to
- analyze tasks in the field of basics of picture scannings and to formulate requirements mathematically,
- describing of picture data reduction systems
- declaring picture transmission systems.
- describing basic principles of color

The students
• are able to check theoretical results using practical realizations,
• are able to undertake theoretical approaches a systematic analysis using methodical procedures and
• are, due to the precise treatment of the contents, in a position to continue their learning themselves

Implementation

• Lectures using the blackboard and presentations,
• Alternating theoretical and practical exercise classes with blackboard
• Demonstration of real technical systems in the lecture hall.

Recommended knowledge

Prior knowledge from the modules Higher Mathematics, Digital Signal Processing and Transmission Techniques is helpful.

Assessment modalitites

Oral exam

Teaching Material, literature

Bereitstellung von elektronischen "Handouts" auf CD.
Literatur:

• Schönfelder, H, Fernsehtechnik im Wandel, Springer Verlag, Heidelberg 1996
• Schiller, Martin et.al , INTERNET: Werkzeuge und Dienste, Springer Verlag, Berlin 1994
• Mäusl, R. , Digitale Modulationsverfahren, Hüthig-Verlag, Heidelberg 1985
• Schönfelder, H., Bildkommunikation, Springer Verlag, Heidelberg 1988
• Jens-Rainer Ohm, Digitale Bildcodierung, Springer Verlag, Berlin 1995
• Reimers, U. (Hrsg.), Digitale Fernsehtechnik (4. Auflage), Datenkompression und Übertragung für DVB, Springer Verlag, Berlin 1995 / 2008
• Hentschel, H.J., Theorie und Praxis der Lichttechnik, Hüthig-Verlag, Heidelberg 1982
• Lang, H., Farbmetrik und Farbensehen, Oldenbourg Verlag, München 1978
• Tauer, Holger, Stereo 3D: Grundlagen, Technik und Bildgestaltung, Verlag Schiele & Schön, Berlin 2011

Comments

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4.60 Wireless Communications

Course	Wireless Communications
Coordination	Prof. Dr.-Ing. Reinhold Häb-Umbach
Teaching Unit	Department of Electrical Engineering and Information Technology
Language	German & English
Type	2 SWS VL, 2 SWS UE
Work load	• 30 h contact hours lectures • 30 h contact hours exercises • 120 h self-study **180 h total workload**
Course homepage	`http://ntws8.upb.de/`
Intended semester	Winter term
Modules using this course	Wireless Communications (S. 45)

Short description

The course on "Wireless Communications" presents an introduction to the principles and techniques for reliable communication over time and/or frequency selective fading channels. The course starts with a detailed discussion of the physical and statistical modeling of wireless communication channels. Next, the most important transmission and receiver techniques will be described, including

- Time diversity: maximum ratio combiner, error rate computation for coherent and incoherent detection, interleaving
- Antenna diversity: tranmit diversity, receive diversity and MIMO techniques
- Frequency diversity: single carrier transmission with sequence detection, direct sequence spread spectrum, multi-carrier techniques

Emphasis will be given on an intuitive understanding of receiver principles from a linear vector space point of view.

Further, an introduction to current cellular systems will be provided: GSM, UMTS and LTE.

Content

- Overview of wireless communication systems
- Channel models: large scale and small scale fading; frequency nonselective and frequency selective fading channels, discrete-time channel model
- Time diversity: Error rate of coherend and noncoherent binary detection over frequency nonselective Rayleigh fading channel, maximum ration combiner
- Antenna diversity: : Single input multiple output (SIMO), multiple input single output (MISO), multiple input multiple output(MIMO), Alamouti-scheme, repetition coding, V-BLAST, suboptimal detection
- Frequency diversity: single-carrier transmission with equalization or sequence detection, direct sequence spread spectrum, orthogonal frequency division multiplex
- Introduction to current cellular communication systems: Global System for Mobile Communication (GSM), Universal Mobile Telecommunication System (UMTS), Long Term Evolution (LTE)

Learning objectives, competences
After completion of the course students will be able to • Develop a discrete-time statistical channel model for a given physical description of a wireless communication channel • Explain the techniques and algorithms used in the Physical Layer of a wireless communication system • Understand the fundamental design options an decisions taken to realize reliable communication over time variant and frequency selective or nonselective fading channels • Appreciate and categorize the techniques used in modern cellular communication systems to realize reliable communication • Trade off the advantages and disadvantages of different transmission techniques with respect to bandwidth and power efficiency as well as number of users to be served • Select and design an appropriate transmission technique for a wireless channel • simulate and analyze simple communication systems using modern software tools The students • Can transfer and apply the concept of linear vector spaces to signal processing tasks other than for wireless communications • Can apply the skills about the generation of data, simulation of systems and analysis of experimental results using modern software tools, that have been acquired in this course, to other disciplines • Can work cooperatively in a team and subdivide an overall task into manageable subtasks and work packages
Implementation
• Lectures predominantly using the blackboard or overhead projector, as well as presentations of (powerpoint) slides , • Exercise classes with exercise sheets and demonstrations on computer and • Implementation of discrete-time channel models and building blocks of a wireless communication system using modern software tools; evaluation and presentation of the simulation results
Recommended knowledge
Elementary knowledge digital communications, as is taught in Bachelor studies of Electrical Engineering or related disciplines, are helpful.
Assessment modalitites
Oral exam
Teaching Material, literature
Course script and summary slides are provided to the students. Exercises and solutions to exercises, as well as sample implementations of algorithms are provided to the students. Further literature • D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005. • K.-D. Kammeyer, Nachrichtenübertragung, Teubner, 2004.

Comments
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