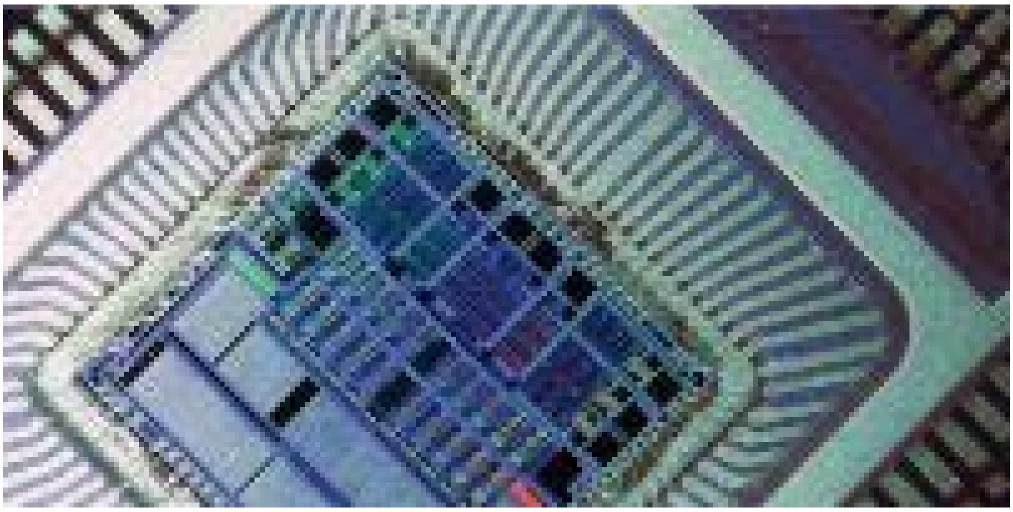
Technische Universität Hamburg-Harburg

Module Handbook

Master-Program
Microelectronics and Microsystems



January 2010

Table of Contents

Subject Module I: Microelectronics

Elective Modules

Module: Electronic Devices

Course Units:

Title	*Type*	*Duration*
Electronic Devices	Lecture	2

Module Responsible:

Dr. D. Schröder

Prerequisites:

None

Recommended Previous Knowledge:

Basic knowledge of (solid-state) physics and mathematics.

Learning Outcomes:

The goal of this course is to provide a very fundamental understanding of the intrinsic mechanisms and the electric terminal behaviour of electronic devices.

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: Electronic Devices

Lecturer:

Dr. D. Schröder

Language:

English

Period:

Winter Semester

Contents:

First, the basic description of electron transport in semiconductors is introduced. Subsequently, electronic operating principles of diodes, MOS capacitors, and MOS field-effect transistors are presented. The way to derive mathematical device models from physical principles is described in much detail. These models allow the understanding and simulation of electronic circuits built from the devices.

Reading Resources:

Yuan Taur, Tak H. Ning: Fundamentals of Modern VLSI Devices,Cambridge University Press 1998, ISBN 0-521-55959-6
TU-Library: EKH-738 (Lehrbuchsammlung)

Module: CMOS-Nanoelectronics

Course Units:

Title	*Type*	*Duration*
CMOS-Nanoelectronics	Lecture	2
Exercise: CMOS-Nanoelectronics	Exercise	1

Module Responsible:

Prof. Krautschneider

Prerequisites:

None

Recommended Previous Knowledge:

Good knowledge about MOS devices and basics of semiconductor physics
Lectures about "Circuit Design"

Learning Outcomes:

Knowledge: Operation of MOS transistors with very small structure sizes. Important procedures for determination of reliability-relevant parameters
Skills: Analysis of highly integrated logic and memory circuits
Competence: Structuring complex circuit modules and Overcoming technological and physical barriers when structures sizes are scaled down

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: CMOS-Nanoelectronics

Lecturer:

Prof. Krautschneider

Language:

English

Period:

Winter Semester

Contents:

- MOS transistor physics in the nanometer range
- High density memory circuits for Gigabit
- Circuit design for highly integrated circuits
- CMOS technology for nanometer devices
- Parasitc effects of very small MOS transistors
- Reliability issues of nanometer MOS transistors

Reading Resources:

Y. Taur und T.H. Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 8th reprint, 2006
R.F. Pierret, Advanced Semiconductor Fundamentals, Prentice Hall, 2003
K. Rim, 32 nm CMOS Technology, IEDM Short Course, 2006

Module: Circuit Design

Course Units:

Title	*Type*	*Duration*
Circuit Design	Lecture	2
Exercise: Circuit Design	Exercise	1

Module Responsible:

Prof. Krautschneider

Prerequisites:

None

Recommended Previous Knowledge:

Basic knowledge in electrical engineering and electronic devices

Learning Outcomes:

Knowledge: Understanding of device behavior for different circuit applications.

Skills: Development of precise knowledge on the function basic analog and digital circuits.

Competence: Ability to evaluate the potential and problems of future CMOS generations.

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Circuit Design

Lecturer:

Prof. Krautschneider

Language:

English

Period:

Winter Semester

Contents:

- MOS transistor as four terminal devices
- Performance degradation due to short channel effects
- Scaled-down CMOS technology
- Digital and analog circuits
- Operational amplifiers
- Basic Bipolar and BICMOS circuits

Reading Resources:

R. J. Baker, H. W. Li, D. E. Boyce: CMOS-Circuit Design, Layout and Simulation, IEEE Press, 1998

Module: Microelectronic Materials

Course Units:

Title	*Type*	*Duration*
Microelectronic Materials	Lecture	2

Module Responsible:

Prof. Bauhofer

Prerequisites:

None

Recommended Previous Knowledge:

Basics in solid state physics, in particular semiconductor physics

Learning Outcomes:

Knowledge:
- in-depth knowledge about material properties which are of particular relevance for microelectronic applications
- important characterization methods
- modern developments in the field of microelectronic materials

Competence of Methods: Ability to judge the potential of new materials for potential applications in microelectronics

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: Microelectronic Materials

Lecturer:

Prof. Bauhofer

Language:

English

Period:

Winter Semester

Contents:

I. Semiconductors

- Crystal structures
- Energy gap and periodic table
- Lattice dynamics
- Electronic band structure
- Impurity levels
- Optical properties

- Modern developments: Semiconductors for the blue spectral region, plastic electronics, carbon nanotubes

II. Isolators

- The Si/SiO2 interface
- Dielectrica for ULSI

III. Metals

- Metallization for integrated circuits, silicides
- Metal/semiconductor interface
- Magnetoelectronics (MRAMs)

Reading Resources:

G. Burns: Solid State Physics, Academic Press, 1985
Karl W. Böer: Survey of Semiconductor Physics, Van Nostrand Reinhold, 1990

Module: Electronic Circuits for Medical Applications

Course Units:

Title	*Type*	*Duration*
Electronic Circuits for Medical Applications	Lecture	2
Exercise: Electronic Circuits for Medical Applications	Exercise	1

Module Responsible:

Prof. Krautschneider

Prerequisites:

None

Recommended Previous Knowledge:

Basic knowledge about analog and digital electronic circuits with MOS transistors

Learning Outcomes:

Knowledge: Understanding of the generation of bioelectrical potentials in organisms. Detailled knowledge about picking-up small bioelectrical signals. Understanding the functionality of realized systems for ECG and EEG signal acqusition.
Competence to provide solutions: Getting the ability to describe and solve comlex problems of the interaction between humans and computers

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Electronic Circuits for Medical Applications

Lecturer:

Prof. Krautschneider

Language:

English

Period:

Winter Semester

Contents:

- Information transfer by nerve fibres in the human body
- Biocompatibility of electrodes
- Acquisition of very small electrical signals
- Design of low-noise amplifiers and very precise analog-digital converters
- Signal processing with extremely small power consumption
- Wireless data transmissin and power supply for implanted devices

Reading Resources:

Vorlesungsskript
G. Matthews, Neurobiology, 2nd edition, Blackwell Science, 2001
W. Sansen, Analog Design Essentials, Springer, 2006

Module: 2D Microelectronic Systems

Course Units:

Title	*Type*	*Duration*
2D Microelectronic Systems	Lecture	2

Module Responsible:

Prof. Bauhofer

Prerequisites:

None

Recommended Previous Knowledge:

Basics semiconductor physics

Learning Outcomes:

Knowledge: Broad theoretical and methodological knowledge of 2D Micorelectronic Systems
Skills: Understanding of problems, creative usage of scientific problem analysis
Competence: Systematic problem solving behaviour

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: 2D Microelectronic Systems

Lecturer:

Prof. Bauhofer

Language:

English

Period:

Summer Semester

Contents:

- Quantum mechanical description of localisation in one dimension
- Preparation and characterisation of two-dimensional semiconductor systems
- 2D heterostructures
- Transistors
- SiGe
- Optical devices
- Quantum cascade laser
- 2D systems in a magnetic field

Reading Resources:

Weisbuch/Vinter: Quantum Semiconductor Structures, Academic Press, 1991
John H. Davies: The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1999
M. J. Kelly: Low-Dimensional Semiconductors, Oxford Science Publications, 1995

Module: Optoelectronics I: Wave Optics

Course Units:

Title	*Type*	*Duration*
Opotelectronics I	Lecture	2
Exercise: Opotelectronics I	Exercise	1

Module Responsible:

Prof. Eich

Prerequisites:

None

Recommended Previous Knowledge:

Basics in electrodynamics, calculus

Learning Outcomes:

Knowledge: The objective of this course is to provide the fundamentals of optics, electrooptics and optoelectronics principles and selected devices. Detailed knowledge in matrix methods in optics is conveyed.

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Optoelectronics I

Lecturer:

Prof. Eich

Language:

English

Period:

Summer Semester

Contents:

- Introduction to optoelectronics
- Electromagnetic theory of light
- Interference
- Coherence
- Diffraction
- Fourier optics
- Polarisation and Crystal optics
- Matric formalism
- Reflection and transmission
- Complex refractive index
- Dispersion
- Modulation and switching of light

Reading Resources:

Hecht, E., Optics, Benjamin Cummings, 2001, ISBN: 0805385665

Goodman, J.W. Statistical Optics, Wiley, 2000, ISBN: 0471399167

Lauterborn, W., Kurz, T., Coherent Optics: Fundamentals and Applications, Springer, 2002, ISBN: 3540439331

Module: Optoelectronics II: Quantum

Course Units:

Title	*Type*	*Duration*
Opotelectronics II	Lecture	2
Exercise: Opotelectronics II	Exercise	1

Module Responsible:

Prof. Eich

Prerequisites:

None

Recommended Previous Knowledge:

Wave optics, elementary quantum mechanics, differential equations

Learning Outcomes:

Knowledge: Understanding of fundamental principles of light generation, light detection and of light matter interaction. Detailed knowledge about laser physics and methods to describe the spectral properties and switching behaviour of lasers is conveyed.

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Optoelectronics II

Lecturer:

Prof. Eich

Language:

English

Period:

Winter Semester

Contents:

- Introduction to optoelectronics
- Electromagnetic theory of light
- Interference
- Coherence
- Diffraction
- Fourier optics
- Polarisation and Crystal optics
- Matric formalism
- Reflection and transmission
- Complex refractive index
- Dispersion
- Modulation and switching of light

Reading Resources:

Demtröder, W., Laser Spectroscopy: Basic Concepts and Instrumentation, Springer, 2002, ISBN: 354065225
Kasap, S.O., Optoelectronics and Photonics: Principles and Practices, Prentice Hall, 2001, ISBN: 0201610876
Yariv, A., Quantum Electronics, Wiley, 1988, ISBN 0471609978
Wilson, J., Hawkes, J., Optoelectronics: An Introduction, Prentice Hall, 1997, ISBN: 013103961X
Siegman, A.E., Lasers, University Science Books, 1986, ISBN: 0935702113

Subject Module II: Microsystems

Elective Modules

Module: Microsystem Engineering

Course Units:

Title	*Type*	*Duration*
Microsystems	Lecture	2
Exercise: Microsystems	Exercise	1

Module Responsible:
Prof. Kasper

Prerequisites:

None

Recommended Previous Knowledge:

Fundamentals of semiconductor technology, physics and electric engineering

Learning Outcomes:

Knowledge: Technologies and material of MEMS, applications in sensors and actuators
Skills: Broad understanding of microsystem engineering
Competence: Analysis and description of the functional behaviour and evaluation of the potential of microsystems

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Wirtten Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Microsystem Engineering

Lecturer:

Prof. Kasper

Language:

English

Period:

Winter Semester

Contents:

Introduction

- Object and goal of MST
- Micro - Macro
- Scaling Rules
- Similitude and dimensionless numbers

Technologies, Materials, Processes

- Lithography

- Film deposition
- Structuring and etching
- Processes

System Integration

- Trends in System integration, electronic components
- Wiring capacity and wiring demand
- Packaging technologies, Multi-Chip-Modules
- Yield, test and reliability

Actuators

- Energy conversion and force generation
- Electromagnetic Actuators
- Reluctance motors
- Piezoelectric actuators, bi-metal-actuator
- Friction and wear

Sensors

- Transducer principles
- Signal detection and signal processing
- Mechanical and physical sensors
- Acceleration sensor, pressure sensor
- Sensor arrays

Reading Resources:

M. Kasper: Mikrosystementwurf, Springer (2000)
M. Madou: Fundamentals of Microfabrication, CRC Press (1997)

Module: Microsystem Techologies

Course Units:

Title	*Type*	*Duration*
Microsystem Technologies	Lecture	2
Exercise: Microsystem Technologies	Exercise	1

Module Responsible:

Prof. J. Müller

Prerequisites:

None

Recommended Previous Knowledge:

Basics in physics, microelectronics, mechanics

Learning Outcomes:

Knowledge: materials and methods to process sensors, actuators, and microsystems to generate complex systems similar to micro electronics for physical, chemical, biological and optical parameters for applications in mechanical, fluidic and optical Systems.

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Microsystem Techologies

Lecturer:

Prof. J. Müller

Language:

English

Period:

Winter Semester

Contents:

- Basic physical properties of sensors and actuators,
- basic technologies for microsystems: silicon micromachining, polymer-micromachining, thin and thick film technology, plasma and wet etching, electroforming and moulding,
- encapsulation and bonding main combination technologies: Silicon surface and volume micro-machining, LIGA- and SiGA- process,
- Microsystems: chemical sensors, micro-analysis systems, spectrometers, pressure, force and acceleration sensors

Reading Resources:

A. Heuberger, Mikromechanik, Springer Verlag Berlin 1989
W.Menz, P.Bley, Mikrosystemtechnik für Ingenieure, VCH, Weinheim 1997
F. Völklein, T. Zetterer, Einführung in die Mikrosystemtechnik, Vieweg Braunschweig,, 2000
M.Madou, Fundamentals of Microfabrication, CRC Press, New York, 1997

Module: Microsystem Design

Course Units:

Title	*Type*	*Duration*
Microsystem Design	Lecture	2
Laboratory: Microsystem Design	Laboratory	2

Module Responsible:

Prof. Kasper

Prerequisites:

None

Recommended Previous Knowledge:

Basics of numerical linear algebra, Laplace transformation and an introductory course in microsystems

Learning Outcomes:

Knowledge: Design and simulation methods for microsystems
Competence of Methods: Modelling and description of the functional behaviour
Problem Solving Competence: Selection and evaluation of simulation methods

ECTS Credit Points:

5

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 56, Self-study: 94

Course Unit: Microsystem Design

Lecturer:

Prof. Kasper

Language:

English

Period:

Summer Semester

Contents:

Design methodology

- Design methods, design flow
- Specification
- General solution methods

System simulation

- Levels of simulation, network simulation
- Solution of systems of ordinary differential equations
- Solution of systems of nonlinear equations

Makromodeling

- Concept
- Black-box models
- System identification

Description by means of network models

- Preconditions
- Reduction to resistive networks

Numerical field simulation

- Finite difference, approximation error
- Galerkin method, finite element discretization
- Complexitiy, order of convergence
- Error estimation, mesh refinement

Physical design and system integration

- Partitioning
- Placement problem
- General coupling and reliability constraints

Reading Resources:

M. Kasper: Mikrosystementwurf, Springer (2000)
S. Senturia: Microsystem Design, Kluwer (2001)

Subject Module III: Communication

Elective Modules

Module: Communication Networks I: Principles

Course Units:

Title	*Type*	*Duration*
Communication Networks I	Lecture	2
Exercise: Communication Networks I	Exercise	1

Module Responsible:

Prof. Timm-Giel

Prerequisites:

None

Recommended Previous Knowledge:

Probability theory fundamentals, Poisson process

Learning Outcomes:

- After successful completion of this course students should be able to
- to identify and to explain principles and generic problems of communication networks and protocols
- to explain solution methods of the different problem classes
- to develop solutions for problem statements similar to the generic paradigms
- to participate in English based communication during the lesson

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Communication Networks I

Lecturer:

Prof. Timm-Giel

Language:

English

Period:

Winter Semester

Contents:

- Influence of topology on network properties
- Synchronization at different hierarchical levels
- Error handling (detection, correction, repeat request)
- Flow control (window technique, channel utilization)
- Routing (shortest path routing, bifurcated routing, broadcast routing)
- Multiple access protocols (TDMA, reservation, token, ALOHA, CSMA, CSMA/CD)

- OSI reference model
- Interworking (bridges, routers)
- TCP/IP

Reading Resources:

F. Halsall: Data Communications, Computer Networks and Open Systems, 4th ed., Addison Wesley (1995-97)
A.S. Tanenbaum: Computer Networks, 4th ed., Pearson Education International (2003)
Larry L. Peterson & Bruce S.Davie: Computer Networks, Morgan Kaufmann Publisher (2000)
James F. Kurose & Keith W. Ross: Computer Networking, Pearson/Addison Wesley (2005)
A.S. Tanenbaum: Computernetzwerke, 4.Aufl.,Pearson Studium (2003)

Module: Optical Communications

Course Units:

Title	*Type*	*Duration*
Optical Communications	Lecture	2
Exercise: Optical Communications	Exercise	1

Module Responsible:

Prof. Brinkmeyer

Prerequisites:

None

Recommended Previous Knowledge:

Fundamentals of electromagnetic theory, communications, waveguide theory, and electronic devices

Learning Outcomes:

Knowledge: Understanding basic principles of optical communications
Competencies: Abilities of designing and evaluating optical transmission systems

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Optical Communications

Lecturer:

Prof. Brinkmeyer

Language:

English

Period:

Winter Semester

Contents:

- Review of optical waveguide fundamentals
- Properties of silica optical fiber relevant in communications
- Passive components in fiber optics
- Review of photodiode and LED fundamentals
- Noise in photodetectors
- Laserdiodes
- Optical fiber amplifiers
- Nonlinearities in optical fibers
- Optical fiber systems

Reading Resources:

G.P. Agrawal: Fiber-optic communication system. John Wiley&Sons, 2002
J. Gowar: Optical communication systems, Prentice-Hall, 1997
I.P. Kaminov, L. Koch (ed.): Optical Fiber Telecommunications, vol. IIIa, IIIb, Academic Press 1997
E. Voges, K. Petermann (ed.): Optische Kommunikationstechnik, Springer, 2002

Module: Microwave Engineering

Course Units:

Title	*Type*	*Duration*
Microwave Engineering	Lecture	2
Exercise: Microwave Engineering	Exercise	1

Module Responsible:

Prof. Jacob

Prerequisites:

None

Recommended Previous Knowledge:

The lecture is based on fundamentals of communication engineering, semiconductor devices and circuits, and wave propagation.

Learning Outcomes:

Knowledge: In-depth Introduction to the Foundations of Microwave Engineering
Competence of Methods: Dedicated Application of the Theoretical Foundations to the Analysis of Selected Practical Problems

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Microwave Engineering

Lecturer:

Prof. Jacob

Language:

English

Period:

Winter Semester

Contents:

- Antennas: Analysis - Characteristics - Realizations;
- Radio Wave Propagation
- Transmitter: Power Generation with Vacuum Tubes and Transistors;
- Receiver: Preamplifier - Heterodyning - Noise;
- Selected System Applications

Reading Resources:

Voges, E.: Hochfrequenztechnik, Hüthig, 2004

Jacob, A.: Vorlesungsskript (deutsch)

Module: Digital Filters

Course Units:

Title	*Type*	*Duration*
Digital Filters	Lecture	2

Module Responsible:

Prof. Rohling

Prerequisites:

None

Recommended Previous Knowledge:

Fundamentals in linear time-invariant (LTI) system theory

Learning Outcomes:

Knowledge: Overview of analysis and synthesis of digital filters, knowledge of technical details and general design criteria
Competence in methodology: Modelling and assessment of complex systems
Competence in systems: System-oriented thinking
Soft skills: Ability of learning autonomously and efficiently, communication in English

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: Digital Filters

Lecturer:

Prof. Rohling

Language:

English

Period:

Winter Semester

Contents:

- Introduction
  - Discrete-time Systems
  - Transfer Function and Frequency Response
  - Causality and Stability
  - FIR and IIR Systems
  - Signal Flow Graphs
- Finite Impulse Response Digital Filters
  - Transversal Structures
  - Lattice Structures
  - Frequency Sampling Structures
  - Symmetry Properties and Linear Phase
  - Complementary Filters
  - Half-Band Filter

- FIR Filter Design
    - Least Squared Error Design
    - Windows for FIR Filter Design
    - Frequency-Sampling Design
    - Chebyshev Approximation
    - Design of Half-Band Filters
- Infinite Impulse Response Digital Filters
    - Direct-Form Structures
    - Cascade Form Strutures
    - Parallel Form Structures
    - Allpass Structures
    - Recursive Lattice Structures
- IIR Filter Design
    - Bilinear Transformation Method
    - Impulse Invariant Method
    - Matched-Z Transformation Method
    - Frequency Transformations

Reading Resources:

Alan V. Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 1989, ISBN 0-13-216771-1

John G. Proakis, Dimitris G. Manolakis, Introduction to Digital Signal Processing, Macmillan Publishing, 1988, ISBN 0-02-396810-9

Module: Fibre and Integrated Optics

Course Units:

Title	*Type*	*Duration*
Fibre and Integrated Optics	Lecture	2
Exercise: Fibre and Integrated Optics	Exercise	1

Module Responsible:

Prof. Eich

Prerequisites:

None

Recommended Previous Knowledge:

Electrodynamics, Optics

Learning Outcomes:

Knowledge: Theoretical and technological fundamentals in guided wave optics and their application in optical signal processing
Method competence: Modelling and mathematical description of wave propagation in optical fibres and integrated optics. Derivation of approximative solutions.
Systems competence: Design principles of complex systems and holistic comprehension of substantial factors influencing systems performance
Social competence: English language based discussion of complex scientific and technical topics

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Oral Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Fibre and Integrated Optics

Lecturer:

Prof. Eich

Language:

English

Period:

Summer Semester

Contents:

- Theory of optical waveguides
- Coupling to and from waveguides
- Losses
- Linear and nonlinear dspersion
- Components and technical applications

Reading Resources:

Hunsperger, R.G., Integrated Optics: Theory and Technology, Springer, 2002, ISBN: 3540433414
Agrawal, G.P.,Fiber-Optic Communication Systems, Wiley, 2002, ISBN 0471215716

Marcuse, D., Theory of Dielectric Optical Waveguides, Academic Press,1991, ISBN 0124709516
Tamir, T. (ed), Guided-Wave Optoelectronics, Springer, 1990, ISBN 038752780X

Module: Mobile Communications

Course Units:

Title	*Type*	*Duration*
Mobile Communications	Lecture	2
Exercise: Mobile Communications	Exercise	1

Module Responsible:

Prof. Rohling

Prerequisites:

None

Recommended Previous Knowledge:

Fundamentals in linear time-invariant (LTI) system theory

Learning Outcomes:

Knowledge: Overview of existing and new mobile communication systems,knowledge of technical details and general design criteria
Competence in methodology: Modelling and assessment of complex systems
Competence in systems: System-oriented thinking
Soft skills: Ability of learning autonomously and efficiently, communication in English

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Mobile Communications

Lecturer:

Prof. Rohling

Language:

Englisch

Period:

Summer Semester

Contents:

- Mobile radio channels: Properties, deterministic and stochastic channel models
- Digital transmission techniques: single and multicarrier transmission, modulation schemes
- Channel estimation and equalization techniques
- Channel coding methods which are suitable for radio channels
- Diversity reception and combining techniques
- Multiple access schemes for single and multicarrier transmission
- Transmission protocols and aspects of cellular networks
- A comprehensive comparison of the transmission technique used in current systems like GSM, HIPERLAN, and DAB

Reading Resources:

John G. Proakis, Digital Communications (3rd Edition), McGraw-Hill, 1995 ISBN 0-07-051726-6

Subject Module IV: Comupter Science and Signal Processing

Elective Modules

Module: Computational Web

Course Units:

Title	*Type*	*Duration*
Computational Web	Lecture	2
Exercise: Computational Web	Exercise	1

Module Responsible:

Prof. Weberpals

Prerequisites:

None

Recommended Previous Knowledge:

Students are expected to have a solid knowledge of Software Engineering in general and of Java in particular.

Learning Outcomes:

A glimpse of the emerging Sementic Grid

ECTS Credit Points:

4

Mode of Examination:

Integral Examination

Performance Record:

Written examination

Workload in hours:

Contact Time: 42, Self-study: 78

Course Unit: Computational Web

Lecturer:

Prof. Weberpals

Language:

English

Period:

Winter Semester

Contents:

- Introduction to the Computational Web
- Grid Services Architecture
- Web Services Architecture
- Computational Web Services
- Future Trends
- The Semantic Grid

Reading Resources:

Students are expected to have a solid knowledge of Software Engineering in general and of Java in particular.

Module: Digital Video Signal Coding

Course Units:

Title	*Type*	*Duration*
Digital Video Signal Goding	Lecture	2

Module Responsible:

Prof. Grigat

Prerequisites:

None

Recommended Previous Knowledge:

Linear algebra, basic stochastics, binary arithmetics

Learning Outcomes:

- Knowledge: Broad theoretical and methodological foundations of data compression, advanced training on the example of MPEG-4 AVC
- Competece of Systems and Problem Solving: Understanding of problems, creative usage of scientific problem analysis and mathematical formalization (comparison of lossy and lossless coding schemes based on source models)

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: Digital Video Signal Coding

Lecturer:

Prof. Grigat

Language:

English

Period:

Winter Semester

Contents:

- Information and entropy
- entropy coding (Huffman, arithmetic)
- lossless coding (DPCM, RLC, Ziv-Lempel, CALIC, JPEG-LS)
- quantisation (scalar, vector quantisation)
- transform coding (DCT, hybrid DCT)
- motion estimation
- subband coding

Reading Resources:

Salomon, Data Compression, the Complete Reference, Springer, 2000
Solari, Digital video and audio compression, McGraw-Hill, 1997
Tekalp, Digital Video Processing, Prentice Hall, 1995

Module: 3D Computer Vision

Course Units:

Title	*Type*	*Duration*
3D Computer Vision	Lecture	2

Module Responsible:

Prof. Grigat

Prerequisites:

None

Recommended Previous Knowledge:

Linear Algebra, basics of stochastics

Learning Outcomes:

Knowledge: Broad theoretical and methodological foundations of feature selection and classification, advanced training on the example of parameter estimation for camera calibration
Skills: Understanding of problems, creative usage of scientific problem analysis and mathematical formalization (calibration of a real camera, lens errors)
Competence: Theory-driven application of very demanding methods and procedures (Plücker matrices, strong and weak calibration, DLT, EM, trifocal tensor)

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 28, Self-study: 72

Course Unit: 3D Computer Vision

Lecturer:

Prof. Grigat

Language:

English

Period:

Summer Semester

Contents:

- Projective Geometry and Transformations in 2D und 3D
- Epipolar Geometry and the Fundamental Matrix
- Homographies
- Trifocal Tensor

Reading Resources:

Skriptum Grigat/Wenzel
Hartley, Zisserman: Multiple View Geometry in Computer Vision. Cambridge 2003.

Module: Digital Signal Processors

Course Units:

Title	*Type*	*Duration*
Digital Signal Processors	Lecture	2

Modue Responsible:

Prof. Mayer-Lindenberg

Prerequisites:

None

Recommended Previous Knowledge:

Knowledge on linear systems, digital filters, digital systems and microprocessors.

Learning Outcomes:

Knowledge about state-of-the-art DSP hardware
Conpetence to design cost-effective DSP systems for given requirements

ECTS Credit Points:

3

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 28, Self-study: 68

Course Unit: Digital Signal Processors

Lecturer:

Prof. Mayer-Lindenberg

Language:

Englisch

Period:

Summer Semester

Contents:

- of digital signal processing
- FIR filter processor design using a multiplier accumulator
- Integrated signalprocessors
- DSP system design, host ports, converters
- fast Fourier transform and filtering in the frequency domain
- Floating point DSP, FFT and fast FIR applications
- parallel DSP systems
- comparison to fast general purpose processors
- FPGA computing and DSP on FPGA
- special purpose processors for graphics and multimedia

Reading Resources:

F. Mayer-Lindenberg, Dedicated Digital Processors, Wiley 2004
J. G. Proakis, Digital Signal Processing, Prentice Hall 1996

Module: Digital Audio Signal Processing

Course Units:

Title	*Type*	*Duration*
Digital Audio Signal Processing	Lecture	2

Module Responsible:

Prof. Zölzer

Prerequisites:

None

Recommended Previous Knowledge:

Signals and systems, Fourier, Laplace and Z transforms

Learning Outcomes:

Knowledge: Principles of digital audio signal processing with broad theoretical fundamentals.
Competence of Methods: Theory driven applications of methods for advanced signal processing.
Competence of Problem Solving: Identification of problems and creative application of scientific methods and strategies for solving problems.

ECTS Credit Points:
3

Mode of Examination:

Integral Examination

Performance Record:

Written Examination

Workload in hours:

Contact Time: 28, Self-study: 62

Course Unit: Digital Audio Signal Processing

Lecturer:

Prof. Zölzer

Language:

English

Period:

Winter Semester

Contents:

- Introduction (Studio Technology, Digital Transmission Systems, Storage Media, Audio Components at Home)
- Quantization (Signal Quantization, Dither, Noise Shaping, Number Representation)
- AD/DA Conversion (Methods, AD Converters, DA Converters, Audio Processing Systems, Digital Signal Processors, Digital Audio Interfaces, Single-Processor Systems, Multiprocessor Systems)
- Equalizers (Recursive Audio Filters, Nonrecursive Audio Filters, Multi-Complementary Filter Bank)
- Room Simulation (Early Reflections, Subsequent Reverberation, Approximation of Room Impulse Responses)
- Dynamic Range Control (Static Curve, Dynamic Behavior, Implementation, Realization Aspects)
- Sampling Rate Conversion (Synchronous Conversion, Asynchronous Conversion, Interpolation Methods)
- Data Compression (Lossless Data Compression, Lossy Data Compression, Psychoacoustics, ISO-MPEG1 Audio Coding)

Reading Resources:

U. Zölzer, Digitale Audiosignalverarbeitung, 3. Aufl., B.G. Teubner, 2005.
U. Zölzer (Ed), Digital Audio Effects, J. Wiley & Sons, 2002.

Assignment and Thesis

Compulsory Modules

Module: Project Work

Module Responsible:

A professor of the TUHH

Prerequisites:

none

Recommended Previous Knowledge:

All knowledge, skills and competencies that are taught and developed in the first year.

Learning Outcomes:

The students are able to work scientifically correct. They have the ability to complete and document research on a subject matter assignment with scientific methods independently and within a given timeframe. The students are able to develop solutions for technical problems on the basis of pure science with regards to safety, environmental, ethical and economic aspects.

ECTS Credit Points:

15

Mode of Examination:

Integral Examination

Performance Record:

Project work and oral exam

Workload:

Self-study: 450

Module: Master Thesis

Module Responsible:

A professor of the TUHH

Prerequisites:

Achievements of at least 80 ECTS from the the curriculum

Recommended Previous Knowledge:

All knowledge, skills and competencies that are taught and developed in semesters 1-3.

Learning Outcomes:

The graduates have the necessary competencies for correct scientific work and are able to write profound research papers. They have the ability to complete research on a pure science subject matter with sophisticated scientific methods independently and within a given timeframe. The students are able to analyze and evaluate possible solutions for the given problem and can put their work into the context of current research.

ECTS Credit Points:

30

Mode of Examination:

Integral Examination

Performance Record:

Thesis and Presentation

Workload:

Self-study: 900