Module Handbook

Master-Program
Information and Communication Systems

January 2010
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Speciality Module I: Software for Information and Communication Systems

Elective Modules

Module: Computational Web

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<td>Computational Web</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Computational Web</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

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 Semantic 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: Verified Software Systems

Course Units:

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Verified Software Systems</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Verified Software Systems</td>
<td>Exercise</td>
<td>2</td>
</tr>
</tbody>
</table>

Module Responsible:
Prof. Schupp

Prerequisites:
None

Recommended Previous Knowledge:
Discrete mathematics

Learning Outcomes:

Knowledge: Foundational theories, methods, and techniques for verifying software systems

Skills: Practical experience with relevant tools

Competencies: Assessing and applying different logics, methods, and tools

ECTS Credit Points:
5

Mode of Examination:
Integral Examination

Performance Record:
Written exam

Workload in hours:
Contact Time: 45, Self-study: 105

Course Unit: Verified Software Systems

Lecturer:
Prof. Schupp

Language:
English

Period:
Winter Semester

Contents:
Propositional logic, predicate logic, model checking, modal logic, program verification
Algorithms, modelling languages, tools

Reading Resources:
M. Huth, M. Ryan, Logic in Computer Science, Modeling and Reasoning about Systems, Cambridge University Press, 200
Module: Software for Embedded Systems

Course Units:

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<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Software for Embedded Systems</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Software for Embedded Systems</td>
<td>Exercise</td>
<td>2</td>
</tr>
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</table>

Module Responsible:
Prof. Turau

Prerequisites:
None

Recommended Previous Knowledge:
- Bachelor in Computer Science or electrical engineering
- Programming language C
- Generally Comprehension of Microprocessors Learning

Learning Outcomes:
Knowledge: Basic Principles and Procedures for the Design of Software for Embedded Systems
Expertise: Analysis of Complex Activities with Temporal Constraints
Competencies: Modularization of Complex Systems

ECTS Credit Points:
5

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 45, Self-study: 105

Course Unit: Software for Embedded Systems

Lecturer:
Prof. Turau

Language:
English

Period:
Summer Semester

Contents:
- Introduction to Embedded Systems
- Software Development for Embedded Systems
- Concurrent systems
- Real Time
- Programming Embedded Systems
- Operating for Embedded Systems Reading

Reading Resources:
Peter Marwedel, Eingebettete Systeme, Springer Verlag, 2007
Peter Scholz, Softwareentwicklung eingebetteter Systeme, Springer Verlag, 2005
Peter Liggesmeyer, Dieter Rombach (Hrsg.): Software Engineering eingebetteter Systeme. Grundlagen - Methodik - Anwendungen. Spektrum Akademischer Verlag, 2005
Module: Software Analysis

Course Units:

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<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Software Analysis</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Software Analysis</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

Module Responsible:
Prof. Schupp

Prerequisites:
None

Recommended Previous Knowledge:
Imperative and object-oriented programming; standard data structures in computer science; discrete mathematics.

Learning Outcomes:
Knowledge: Standard approaches, methods, and algorithms for automated program analysis
Skills: Practical experience with applications and tools
Competencies: Evaluation and assessment of different approaches and techniques

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 42, Self-study: 48

Course Unit: Software Analysis

Lecturer:
Prof. Schupp

Language:
English

Period:
Summer Semester

Contents:
- Intermediate representations and models;
- Intraprocedural data flow analysis;
- Interprocedural analysis;
- Source-code analysis;
- Testing;
- Applications in program understanding

Reading Resources:
Module: Object-Oriented System Development in Process Automation

Course Units:

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<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Object-Oriented System Development in Process Automation</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Object-Oriented System Development in Process Automation</td>
<td>Exercise</td>
<td>2</td>
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</table>

Module Responsible:
Prof. W. Meyer

Prerequisites:
None

Recommended Previous Knowledge:
Basic knowledge in software engineering and programming, e.g. a procedural language. Recommended though not mandatory: lecture 'Industrial Process Automation' by Prof. W. Meyer

Learning Outcomes:
Knowledge: Unified Modelling Language UML, Constraint based representation ILOG OPL, Object-oriented language Smalltalk
Abilities: Object-oriented modelling of complex planning systems with UML
Competence of Systems: Formal UML models for industrial processes
Problem Solving Competence: Evaluation of different problem representations, specially of constraint and object-based approaches for the industrial software package AIPLANNER
Social Competence: Social interaction within project groups for the realisation of software modules like the "Event-driven Simulator for industrial Transport Systems"

ECTS Credit Points:
5

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 45, Self-study: 105

Course Unit: Object-Oriented System Development in Process Automation

Lecturer:
Prof. W. Meyer

Language:
English

Period:
Summer Semester

Contents:
- Basic Definitions: Graphs and networks
- Problem Domain: Setup time minimization in Electronics Industry
- Application Software: AIPLANNER planning software package
- Object-oriented Modelling: Principles and methods
- Object-oriented Modelling Languages: UML and Poseidon
- Object-oriented Model: Remodelling AIPLANNER with UML
- Object-based Metrics: Measuring the quality of object-based software
- Constraint Programming: Time logics
- Agent Programming: UML extensions

Reading Resources:
J. Brauer: "Grundkurs Smalltalk - Objektorientierung von Anfang an". Vieweg Verlag, Wiesbaden 2003
B. Oestereich: "Objektorientierte Softwareentwicklung". Oldenbourg Verlag, München 1998
Module: Foundations of Machine Learning and Data Mining

Course Units:

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<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tr>
<td>Foundations of Machine Learning and Data Mining</td>
<td>Lecture</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Foundations of Machine Learning and Data Mining</td>
<td>Exercise</td>
<td>1</td>
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Module Responsible:
Prof. R. Möller

Prerequisites:
None

Recommended Previous Knowledge:
Elementary knowledge in Computer Science and Mathematics as usual for a Master course.

Learning Outcomes:
- Knowledge foundational techniques, theories and methods of Machine Learning and Data Mining
- Capabilities for applying theory-based learning procedure in the context of industrial problems
- Skills for assessing the pros and cons of specific learning procedures

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Written examination

Workload in hours:
Contact Time: 42, Self-study: 78

Course Unit: Foundations of Machine Learning and Data Mining

Lecturer:
Prof. R. Möller

Language:
English

Period:
Summer Semester

Contents:
- Introduction
- Learning from observations
- Inductive learning, introduction to learning decision trees
- Decision tree learning
- Information theory, information gain (ID3), extensions (C4.5), translating decision trees to rules
- Computational learning theory (PAC learning), incremental learning (version spaces)
- Uncertainty
- Bayesian networks
- Learning parameters of Bayesian networks
- BME, MAP, ML, EM algorithm
- Learning structures of Bayesian networks
- kNN-Classifier, neural network classifier, support vector machine (SVM) classifier
- Clustering
• Distance measures, k-means clustering, nearest neighbor clustering
• Knowledge in learning
• Inductive logic programming
• Learning of probabilistic relational models (PRMs)

Reading Resources:

Chapters 13-14, 18-21.

Introduction to Machine Learning Ethem Alpaydin, MIT Press, 2004
Module: Software Security

Course Units:

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<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Software Security</td>
<td>Lecture</td>
<td>2</td>
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<tr>
<td>Exercise: Foundations of Machine Learning and Data Mining</td>
<td>Exercise</td>
<td>1</td>
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</table>

Module Responsible:
Prof. Gollmann

Prerequisites:
None

Recommended Previous Knowledge:
Familiarity with C or C++; object-oriented progra

Learning Outcomes:
- Knowledge: Major causes for software vulnerabilities; current practices for identifying and avoiding software vulnerabilities; fundamentals of code-based access control.
- Competencies: Vulnerability analysis of code and software systems; secure programming.

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 42, Self-study: 78

Course Unit: Software Security

Lecturer:
Prof. Gollmann

Language:
English

Period:
Winter Semester

Contents:
- Reliability & software security
- Unicode attacks
- Integer overflows
- Buffer overflows
- Race conditions
- Security testing
- Type-safe languages
- SQL attacks
- Scripting languages
- Identity-based access control
- Code-based access control
- Java security model
- .NET CLR security model
• Stack walks and history-based access control

Reading Resources:
Module: Project Seminar

Course Units:

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<th>Title</th>
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<th>Duration</th>
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<tr>
<td>Seminar: Realization of an I&amp;K Application System</td>
<td>Seminar</td>
<td>1</td>
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<tr>
<td>Exercise: Realization of an I&amp;K Application System</td>
<td>Project</td>
<td>3</td>
</tr>
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Module Responsible:
Prof. Schupp

Prerequisites:
None

Recommended Previous Knowledge:
- Bachelor in computer science
- Basic knowledge of a (preferably object-oriented) programming language
- Familiarity with basic concepts of the Internet

Learning Outcomes:
Knowledge: Concepts, techniques and tools of today’s innovative information and communication systems. In addition, deepened knowledge required for conduction the project depending on the topic
Methodical skills: Learning and applying object-oriented analysis, design and implementation
System skills: Practically experiencing the difficulties of developing a non-trivial system

ECTS Credit Points:
6

Mode of Examination:
Integral Examination

Performance Record:
Presentations, oral participation, submitted programs

Workload in hours:
Contact Time: 52, Self-study: 108

Course Unit: Project Seminar

Lecturer:
Prof. Schupp; Prof. Turau

Language:
English

Period:
Winter Semester

Contents:
- Object-oriented analysis, design and implementation
- An object-oriented programming language (typically: Java)
- Communication protocols
- Further software technologies as required for the project
- Conducting software development projects

Reading Resources:
Ian Sommerville: Software-Engineering. Addison-Wesley. (Grundlagen: Analyse, Design, Realisierung)
(Kompakte Einführung in die UML-Notation)
E. Gamma, R. Helm, R. Johnson, J. Vlissides: Design Patterns, Elements of Reusable Object-Oriented Software.
Addison-Wesley, 1995.
Speciality Module II: Digital Signal Processing

Elective Modules

Module: Adaptive Compute Systems

Course Units:

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<th>Title</th>
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<th>Duration</th>
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<tbody>
<tr>
<td>Adaptive Compute Systems</td>
<td>Lecture</td>
<td>2</td>
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Module Responsible:
Prof. Mayer-Lindenberg

Prerequisites:
None

Recommended Previous Knowledge:
Basic Knowledge on algorithms, digital systems
Helpful but not mandatory lectures: "Languages and Algorithms", "Digital Filter", "Signal Processors", "Pattern Recognition"

Learning Outcomes:
Knowledge: This lecture brings together various techniques and algorithms parametrically or in their structure to achieve a better performance in some sense. They cover neural networks, related adaptive filters, genetic optimization and machine learning.

ECTS Credit Points:
3

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 28, Self-study: 62

Course Unit: Adaptive Compute Systems

Lecturer:
Prof. Mayer-Lindenberg

Language:
English

Period:
Winter Semester

Contents:
- natural neural systems
- perceptron and multilayer feed-forward networks
- Hopfield and Kohonen networks. Boltzmann machine, ART
- adaptive FIR and IIR filters and applications
- genetics and evolution in biology
- genetic algorithms
- applications to resource allocation, programming, artificial life and neural structures
- knowledge acquisition and representation
- fuzzy logic and fuzzy data bases
- adaptive data bases
- hardware architectures for neural networks, and adaptive hardware.

**Reading Resources:**

Goos, Vorlesungen über Informatik Band IV, Springer-Verlag
H.Ritter, T.Martinez, K.Schulten, Neuronale Netze
K. Weicker, Evolutionäre Algorithmen, Teubner 2002
Module: Digital Video Signal Coding

Course Units:

<table>
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<tr>
<th>Title</th>
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<th>Duration</th>
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<tr>
<td>Digital Video Signal Coding</td>
<td>Lecture</td>
<td>2</td>
</tr>
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</table>

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
- Competence 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:
2

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 28, Self-study: 62

Course Unit: International Logistics

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
Tekalp, Digital Video Processing, Prentice Hall, 1995
Module: Digital Filters

Course Units:

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<tr>
<th>Title</th>
<th>Type</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Digital Filters</td>
<td>Lecture</td>
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</table>

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
  o Least Squared Error Design
  o Windows for FIR Filter Design
  o Frequency-Sampling Design
  o Chebyshev Approximation
  o Design of Half-Band Filters

• Infinite Impulse Response Digital Filters
  o Direct-Form Structures
  o Cascade Form Structures
  o Parallel Form Structures
  o Allpass Structures
  o Recursive Lattice Structures

• IIR Filter Design
  o Bilinear Transformation Method
  o Impulse Invariant Method
  o Matched-Z Transformation Method
  o Frequency Transformations

Reading Resources:
Alan V. Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 1989,
ISBN 0-13-216771-1
ISBN 0-02-396810-9
Module: Digital Signal Processors

Course Units:

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<tbody>
<tr>
<td>Digital Signal Processors</td>
<td>Lecture</td>
<td>2</td>
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</table>

Module 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
Competence 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
Module: Digital Audio Signal Processing

Course Units:

<table>
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<tr>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>Digital Audio Signal Processing</td>
<td>Lecture</td>
<td>2</td>
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</tbody>
</table>

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)
- 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:**


Module: Digital Image Processing

Course Units:

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<tr>
<th>Title</th>
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<th>Duration</th>
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<tbody>
<tr>
<td>Digital Image Processing</td>
<td>Lecture</td>
<td>2</td>
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<tr>
<td>Exercise: Digital Image Processing</td>
<td>Exercise</td>
<td>1</td>
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Module Responsible:
Prof. Grigat

Prerequisites:
None

Recommended Previous Knowledge:
LTI system theory of one-dimensional signals (sampling theory, interpolation, Fourier transform, linear time-invariant systems), linear algebra (Eigenvalue decomposition), basic stochastics (expectation values and samples)

Learning Outcomes:

Knowledge: Broad theoretical and methodological foundations of imaging capture and processing algorithms, in depth knowledge of digital filtering of image signals. In-depth knowledge of interdisciplinary relations and embedding the field into the scientific and social environment (system theory, filter, physiology, perception psychology)

Competence of Methods: Theory-driven application of very demanding methods and procedures (multidimensional sampling theory, unary transforms, characterization of sensor and display)

Competence of Problem Solving: Understanding of problems, creative usage of scientific problem analysis and mathematical formalization (applications to mobile phone cameras)

Competence of Systems: Quantitative Comparison of competing methodology in multidimensional decision spaces (spatio-temporal signal processing, image deficiencies as an interrelation of perception and signal theory)

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Written examination

Workload in hours:
Contact Time: 42, Self-study: 78

Course Unit: Digital Image Processing

Lecturer:
Prof. Grigat

Language:
English

Period:
Winter Semester

Contents:

- Perception of luminosity and color
- color spaces
- multidimensional sampling in space and time
- decimation, de-interlacing
• large area and edge flicker
• apertures of image sensors and displays in space and time
• image transforms
• image filtering
• edge operators
• histogram equalisation
• morphological operators
• homomorphic filtering
• hough transform
• geometric moments

**Reading Resources:**

Speciality Module III: Networking

Elective Modules

Module: Optical Communications

Course Units:

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<th>Title</th>
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<tr>
<td>Optical Communications</td>
<td>Lecture</td>
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<tr>
<td>Exercise: Optical Communications</td>
<td>Exercise</td>
<td>1</td>
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</table>

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:

J. Gowar: Optical communication systems, Prentice-Hall, 1997
Module: Microwave Engineering

Course Units:

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<th>Title</th>
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<tbody>
<tr>
<td>Microwave Engineering</td>
<td>Lecture</td>
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</tr>
<tr>
<td>Exercise: Microwave Engineering</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

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: Communication Networks I: Principles

Course Units:

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<thead>
<tr>
<th>Title</th>
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<th>Duration</th>
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<tbody>
<tr>
<td>Communication Networks I</td>
<td>Lecture</td>
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</tr>
<tr>
<td>Exercise: Communication Networks I</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

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:

- Introduction to Communication Networks
- OSI – Model
- Basic Principles:
  - 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)
- Sample Networks
  - TCP/IP and the Internet
  - WLAN
  - Mobile Communication Networks
Reading Resources:

J. Schiller, Mobile Communication Networks
M. Bossert, M. Breitbach, Digitale Netze, Teubner Leipzig (1999)
Larry L. Peterson & Bruce S. Davie: Computer Networks, Morgan Kaufmann Publisher (2000)
Module: Queuing Theory for Communication Networks

Course Units:

<table>
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<tr>
<th>Title</th>
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<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>Queuing Theory for Communication Networks</td>
<td>Lecture</td>
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</tr>
<tr>
<td>Exercise: Queuing Theory for Communication Networks</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

Module Responsible:
Prof. Timm-Giel

Prerequisites:
None

Recommended Previous Knowledge:
Probability Theory

Learning Outcomes:
After successful completion of this course students should be able to

- to identify and to explain generic problems and solution approaches for queueing problems in communication networks
- to explain solution methods of the different problem classes
- to develop solutions for problem statements similar to the generic paradigms
- to do queueing systems based modelling and problem solving
- to understand the implications of abstraction steps and trade-offs
- 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: Queuing Theory for Communication Networks

Lecturer:
Prof. Timm-Giel

Language:
English

Period:
Winter Semester

Contents:

- Random variables, stochastic processes, Markov chains
- Poisson process
- Deterministic queueing model
- Birth-death process
- Theorem of Little
- Systems with multiple servers
- M/Gi/1 system
- Static and dynamic priorities
- Token method
- Networks of queues

**Reading Resources:**
Module: Analysis and Structure of Communication Networks

Course Units:

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<thead>
<tr>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>Communication Networks II</td>
<td>Lecture</td>
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</tr>
<tr>
<td>Modern Methods for Modelling of Communication Networks</td>
<td>Labor</td>
<td>2</td>
</tr>
<tr>
<td>Exercise: Communication Networks II</td>
<td>Exercise</td>
<td>1</td>
</tr>
</tbody>
</table>

Module Responsible:
Prof. Timm-Giel

Prerequisites:
None

Recommended Previous Knowledge:
Understanding of basic principles of communication networks and their protocols as presented in "Communication Networks I"

Learning Outcomes:
- After successful completion of this course students should be able to
- to explain principles of discrete event simulations for communication networks
- to explain principles of network planning
- to evaluate network performance using event discrete simulation and network planning tools
- to evaluate the reliability of the simulation results, e.g. using confidence intervals
- to develop solutions for problem statements similar to the generic paradigms
- to participate in English based communication during the lesson

ECTS Credit Points:
6

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 56, Self-study: 124

Course Unit: Communication Networks II: Topical Networking Technologies

Lecturer:
Prof. Timm-Giel

Language:
Englisch

Period:
Summer Semester

Contents:
Discrete Event Simulations
- Random Number Generators
- Statistical Evaluation
- Simulation Systems

Network Planning
- Principles of Network Planning and Optimization
• Exact Methods, e.g. Simplex algorithm, Branch and Bound
• Heuristics, e.g. genetic algorithms, simulated annealing
• Examples

**Reading Resources:**

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**Labor Unit: Modern Methods for Modelling of Communication Networks**

**Lecturer:**
Dr. Kreft

**Language:**
Englisch

**Period:**
Summer Semester

**Contents:**
• Learning the capabilities and the programming of an event-driven simulator
• Definition and modeling of specific problems in the area of communication networks
• Solving the problems by using discrete event simulators and MATLAB
• Understanding of network planning as an optimization problem
• Solving of discrete or mixed integer linear optimization problems

**Reading Resources:**
Module: Introduction to Antenna Theory

Course Units:

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<tr>
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<tbody>
<tr>
<td>Introduction to Antenna Theory</td>
<td>Lecture</td>
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</tr>
<tr>
<td>Exercise: Introduction to Antenna Theory</td>
<td>Exercise</td>
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</tr>
</tbody>
</table>

Module Responsible:
Dr. Kreft

Prerequisites:
None

Recommended Previous Knowledge:
Fundamentals of Maxwell’s theory, transmission line theory

Learning Outcomes:
Knowledge: Detailed Knowledge on Antenna Theory and Applications
Competence of Methods: Analysis of Antennas

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Oral Examination

Workload in hours:
Contact Time: 48, Self-study: 78

Course Unit: Introduction to Antenna Theory

Lecturer:
Dr. Höft

Language:
Englisch

Period:
Summer Semester

Contents:
- Method of analysis: vector potential, duality, equivalent sources, image theory, Huygens principle
- Analysis of basic structures: linear antennas, aperture antennas, array antennas
- Characterising quantities: radiation pattern, gain, radiation resistance, reciprocity, noise
- Transmission of radio and microwaves: bounded and free-space transmission
- Examples of antennas: transmit and receive antennas for EMC, mobile services, strongly focussing antennas, ground station antennas, satellite antennas

Reading Resources:
Module: Mobile Communications

Course Units:

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<tr>
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<tr>
<td>Mobile Communications</td>
<td>Lecture</td>
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<td>Exercise: Mobile Communications</td>
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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:
Module: Network Security

Course Units:

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<tr>
<th>Title</th>
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<tr>
<td>Network Security</td>
<td>Lecture</td>
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<tr>
<td>Exercise: Network Security</td>
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Module Responsible:
Prof. Gollmann

Prerequisites:
None

Recommended Previous Knowledge:
Discrete mathematics, computer networks (TCP/IP)

Learning Outcomes:
Knowledge: Fundamental methods of modern cryptography; currently deployed standard network security protocols and mechanisms
Competencies: Analysis of network security problems; identification of appropriate security solutions

ECTS Credit Points:
4

Mode of Examination:
Integral Examination

Performance Record:
Written Examination

Workload in hours:
Contact Time: 42, Self-study: 78

Course Unit: Network Security

Lecturer:
Prof. Gollmann

Language:
English

Period:
Summer Semester

Contents:

- Security objectives
- Cryptographic services and mechanisms
- Hash functions
- Digital signatures: RSA and DSA
- Encryption algorithms: DES, AES, block cipher modes, stream ciphers
- Cryptanalysis, differential power analysis
- Diffie-Hellman key exchange, Kerberos
- IPsec protocols, mobile IPv6
- SSL/TLS
- GSM/UMTS security protocols
- Firewalls and Intrusion Detection Systems
- Testing network security
Reading Resources:
**Assignment and Thesis**

**Compulsory Modules**

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**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

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**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