

Program of Studies:	Master Program CCT
Name of the module:	Data Networks
Abbreviation:	DN
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Holger Hermanns
Lecturer(s):	Prof. Dr. Holger Hermanns
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	After taking the course students have <ul style="list-style-type: none"> • a thorough knowledge regarding the basic principles of communication networks, • the fundamentals of protocols and concepts of protocol, • Insights into fundamental motivations of different pragmatics of current network solutions, • Introduction to practical aspects of data networks focusing on internet protocol hierarchies
Content:	Introduction and overview Cross section: <ul style="list-style-type: none"> • Stochastic Processes, Markov models, • Fundamentals of data network performance assessment • Principles of reliable data transfer • Protokols and their elementary parts • Graphs and Graphalgorithms (maximal flow, spanning tree) • Application layer: <ul style="list-style-type: none"> • Services and protocols • FTP, Telnet • Electronic Mail (Basics and Principles, SMTP, POP3, ..) • World Wide Web (History, HTTP, HTML) • Transport Layer: <ul style="list-style-type: none"> • Services and protocols

	<ul style="list-style-type: none"> • Addressing • Connections and ports • Flow control • QoS • Transport Protocols (UDP, TCP, SCTP, Ports) • Network layer: <ul style="list-style-type: none"> • Services and protocols • Routing algorithms • Congestion Control • Addressing • Internet protocol (IP) • Data link layer: <ul style="list-style-type: none"> • Services and protocols • Medium access protocols: Aloha, CSMA (-CD/CA), Token passing • Error correcting codes • Flow control • Applications: LAN, Ethernet, Token Architectures, WLAN, ATM • Physical layer • Peer-to-Peer and Ad-hoc Networking Principles
Assessment / Exams:	<ul style="list-style-type: none"> • Regular attendance of classes and tutorials • Qualification for final exam through mini quizzes during classes • Possibility to get bonus points through excellent homework • Final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, Beamer, Applets
Literature:	<ul style="list-style-type: none"> • James F. Kurose, Keith W. Ross: Computer networking : a top-down approach featuring the internet. – 3rd ed. – Boston : Addison-Wesley, 2004. • Dimitri Bertsekas, Robert Gallager: Data networks. – 2nd ed. – Saddle River, NJ : Prentice Hall, 1992. • Gerald J. Holzmann: Design and Validation of Computer Protocols. – Englewood Cliffs, NJ : Prentice–Hall, 1991. • Andrew S. Tanenbaum: Computer networks. – 4th ed. – Upper Saddle River, NJ : Pearson Education, 2003.

Program of Studies:	Master Program CCT
Name of the module:	Computer Architecture
Abbreviation:	CA
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. W.-J. Paul
Lecturer(s):	Prof. Dr. W.-J. Paul
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	After attending this lecture students know how to design pipelined processors with interrupt mechanisms, caches and MMUs. Given a benchmark they know how to analyse, whether a change makes the processor more or less cost effective.
Content:	<p>General comment: constructions are usually presented together with correctness proofs</p> <ul style="list-style-type: none"> • Complexity of Architectures <ul style="list-style-type: none"> ○ Hardware cost and cycle time ○ Compilers and benchmarks • Circuits <ul style="list-style-type: none"> ○ Elementary computer arithmetic ○ Fast adders ○ Fast multipliers • Sequential processor design <ul style="list-style-type: none"> ○ DLX instruction set ○ Processor design • Pipelining <ul style="list-style-type: none"> ○ Elementary pipelining ○ Forwarding

	<ul style="list-style-type: none"> ○ Hardware-Interlock ● Interrupt mechanisms <ul style="list-style-type: none"> ○ Extension of the instruction set ○ Interrupt service routines ○ hardware construction ● Caches <ul style="list-style-type: none"> ○ Specification including consistency between instruction and data cache ○ Cache policies ○ Bus protocol ○ Hardware construction (k-way set associative cache, LRU replacement, realisation of bus protocols by automat) ● Operating System Support <ul style="list-style-type: none"> ○ Virtual and Physical machines ○ Address translation ○ Memory management unit (MMU) construction ○ Virtual memory simulation
Assessment / Exams:	<p>Studying: Students should listen to the lectures, read the lecture notes afterwards and understand them. They should solve the exercises alone or in groups. Students must present and explain their solutions during the tutorials.</p> <p>Exams: Students who have solved 50 % of all exercises are allowed to participate in an oral exam at the end of the semester.</p>
Used Media:	Lectures with blackboard and chalk; occasional support by overhead projector and beamer
Literature:	<p>An updated list of used literature will be issued at the beginning of the semester.</p> <p>Müller-Paul: Computer Architecture: Correctness and Complexity; Springer 2000</p> <p>Current scientific papers</p>

Program of Studies:	Master Program CCT
Name of the module:	Telecommunications I
Abbreviation:	TC I
Subtitle	Digital Transmission & Signal Processing
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	5th semester / At least once every two years
Responsible lecturer:	Prof. Dr.-Ing. Thorsten Herfet
Lecturer(s):	Lecture: Prof. Dr.-Ing. Thorsten Herfet Tutorial task sheets: Dipl.-Ing. Aleksej Spent, M.Eng. Tutorial: N.N. (Student Assistant)
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	The lecture requires a solid foundation of mathematics (differential and integral calculus) and probability theory. The course will, however, refresh those areas indispensably necessary for telecommunications and potential intensification courses and by this open this potential field of intensification to everyone of you.
Aims / Competences to be developed:	Digital Signal Transmission and Signal Processing refreshes the foundation laid in "Signals and Systems" [<i>Modulkennung</i>]. Including, however, the respective basics so that the various facets of the introductory study period (Bachelor in Computer Science, Vordiplom Computer- und Kommunikationstechnik, Elektrotechnik or Mechatronik) and the potential main study period (Master in Computer Science, Diplom-Ingenieur Computer- und Kommunikationstechnik or Mechatronik) will be paid respect to.
Content:	As the basic principle, the course will give an introduction into the various building blocks that modern telecommunication systems do incorporate. Sources, sinks, source and channel coding, modulation and multiplexing are the major keywords but we will also deal with dedicated pieces like A/D- and D/A-converters and quantizers in a little bit more depth. The course will refresh the basic transformations (Fourier, Laplace) that give access to system analysis in the frequency domain, it will introduce derived transformations (z, Hilbert) for the analysis of discrete systems and modulation schemes and it will briefly introduce algebra on finite fields to systematically deal with error correction schemes that play an important role in modern communication systems.
Assessment / Exams:	Regular attendance of classes and tutorials Passing the final exam in the 2nd week after the end of courses. Eligibility: Weekly exercises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.
Used Media:	Lecture Notes/script, Task Sheets, Table of Contents (all

	available online)
Literature:	<p>Literature:</p> <p>Proakis, John G. and Salehi, Masoud: "Communications Systems Engineering", 2nd Edition, 2002, Prentice Hall, ISBN 0-13-061793-8</p> <p>Oppenheim, Alan and Willsky, Alan: "Signals & Systems", 2nd Edition, 1997, Prentice Hall, ISBN 0-13-814757-4</p> <p>Göbel, J.: "Kommunikationstechnik", Hüthig Verlag Heidelberg, 1999, ISBN 3-82-665011-5</p> <p>Ohm, J.-R. und Lüke H.D.: "Signalübertragung 9. Auflage", 2004, Springer, ISBN 3-54-022207-3</p> <p>John G. Proakis: "Digital Communications", McGraw Hill Higher Education, 2001, ISBN 0-07-118183-0</p> <p>Bernd Friedrichs: "Kanalcodierung", Springer, 1995, ISBN 3-54-059353-5</p> <p>Papoulis, A.: "Probability, Random Variables and Stochastic Processes", 1965, McGraw-Hill, ISBN 0-07-119981-0</p> <p>Claude E. Shannon, Warren Weaver: "The Mathematical Theory of Communication", University of Illinois Press, 1963, ISBN 0-25-272548-4</p>

Program of Studies:	Master Program CCT
Name of the module:	Telecommunications II
Abbreviation:	TC II
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr.-Ing. Thorsten Herfet
Lecturer(s):	Lecture: Prof. Dr.-Ing. Thorsten Herfet Tutorial task sheets: Muhammad-Rafey Jameel, M.Sc. Tutorial: Student Assistant
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	Solid foundation of mathematics (differential and integral calculus) and probability theory. The course will build on the mathematical concepts and tools taught in TC I while trying to enable everyone to follow and to fill gaps by an accelerated study of the accompanying literature. "Signals and Systems" as well as "TC I - Digital Transmission and Signal Processing" are strongly recommended but not required. Related core lecture TC I
Aims / Competences to be developed:	TC II will deepen the students' knowledge on modern communications systems and will focus on wireless systems. Since from a telecommunications perspective the combination of audio/visual data – meaning inherently high data rate and putting high requirements on the realtime capabilities of the underlying network – and wireless transmission – that is unreliable and highly dynamic with respect to the channel characteristics and its capacity – is the most demanding application domain.
Content:	As the basic principle the course will study and introduce the building blocks of wireless communication systems. Multiple access schemes like TDMA, FDMA, CDMA and SDMA are introduced, antennas and propagation incl. link budget

	<p>calculations are dealt with and more advanced channel models like MIMO are investigated. Modulation and error correction technologies presented in Telecommunications I will be expanded by e.g. turbo coding and receiver architectures like RAKE and BLAST will be introduced. A noticeable portion of the lecture will present existing and future wireless networks and their extensions for audio/visual data. Examples include 802.11 (with the TGe Quality of Service extensions), 802.16a and the terrestrial DVB system (DVB-T, DVB-H).</p>
Assessment / Exams:	<p>Regular attendance of classes and tutorials Passing the final exam Oral exam directly succeeding the course. Eligibility: Weekly excersises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.</p>
Used Media:	<p>Lecture Notes (OHP), PPT Slides, List of Potentially Asked Questions</p>
Literature:	<p>Literature: Foreground (TC II)</p> <ul style="list-style-type: none"> • •Aura Ganz, Zivi Ganz, Kitty Wongthavarawat: "Multimedia Wireless Networks – Technologies, Standards, and QoS", Prentice Hall, 2004 • Simon Haykin, Michael Moher: "Modern Wireless Communications", Prentice Hall, 2005 • Ulrich Reimers: "Digital Video Broadcasting – The Family of International Standards for Digital Video Broadcasting", Springer, 2005 • William Stallings: "Wireless Communications & Networks 2nd Edition", Prentice Hall, 2005 <p>Background (TC I)</p> <ul style="list-style-type: none"> • John G. Proakis, Masoud Salehi: "Communication Systems Engineering 2nd Edition", Prentice Hall, 2002 • Claude E. Shannon, Warren Weaver: "The Mathematical Theory of Communication", University of Illinois Press, 1963

Program of Studies:	Master Program CCT
Name of the module:	Security
Abbreviation:	SEC
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. M. Backes
Lecturer(s):	Prof. Dr. M. Backes
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	Description, assessment, development and application of security mechanisms, techniques and tools.
Content:	<ul style="list-style-type: none"> • Basic Cryptography, • Specification and verification of security protocols, • Security policies: access control, information flow analysis, • Network security, • Media security, • Security engineering
Assessment / Exams:	<ul style="list-style-type: none"> • Regular attendance of classes and tutorials • Passing the final exam • A re-exam is normally provided (as written or oral examination).
Used Media:	Slides, beamer
Literature:	<p>Matt Bishop: Computer Security, Addison-Weseley, 2003</p> <p>Matt Bishop: Introduction in Computer Security. Addison-Weseley, 2003</p> <p>Johannes Buchmann: Einführung in die Kryptographie, Springer,</p>

	2001 Ross Anderson: Security Engineering. Wiley & Sons, 2001 Claudia Eckert: IT-Sicherheit. Oldenbourg, 2001
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Program of Studies:	Master Program CCT
Name of the module:	Verification
Abbreviation:	VERI
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Holger Hermanns
Lecturer(s):	Prof. Dr. Holger Hermanns, Prof. Dr. Bernd Finkbeiner
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	The students become familiar with the standard methods in computer-aided verification. They understand the theoretical foundations and are able to assess the advantages and disadvantages of different methods for a specific verification project. The students gain first experience with manual correctness proofs and with the use of verification tools.
Content:	<ul style="list-style-type: none"> models of computation and specification languages: temporal logics, automata over infinite objects, process algebra deductive verification: proof systems (e.g., Floyd, Hoare, Manna/Pnueli), relative completeness, compositionality model checking: complexity of model checking algorithms, symbolic model checking, abstraction case studies
Assessment / Exams:	<ul style="list-style-type: none"> Regular attendance of classes and tutorials Passing the final exam A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer, theoretical and practical tool-based exercises

Literature:	<ul style="list-style-type: none"><li data-bbox="531 224 1420 291">• Doron A. Peled: Software Reliability Methods, Springer Verlag, 2001<li data-bbox="531 313 1420 380">• Zohar Manna, Amir Pnueli: Temporal Verification of Reactive Systems – Safety, Springer Verlag, 1995.<li data-bbox="531 403 1420 470">• Edmund M. Clarke, Jr., Orna Grumberg and Doron A. Peled: Model Checking, MIT Press, 2000.

Program of Studies:	Master Program CCT
Name of the module:	Image Processing and Computer Vision
Abbreviation:	
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Joachim Weickert
Lecturer(s):	Prof. Dr. Joachim Weickert
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	For graduate students: none
Aims / Competences to be developed:	Broad introduction to mathematical methods in image processing and computer vision. The lecture qualifies students for a bachelor thesis in this field. Together with the completion of advanced or specialised lectures (9 credits at least) it is the basis for a master thesis in this field.
Content:	<ol style="list-style-type: none"> 1. Basics <ol style="list-style-type: none"> 1.1 Image Types and Discretisation 1.2 Degradations in Digital Images 2. Image Transformations <ol style="list-style-type: none"> 2.1 Fourier Transform 2.2 Image Pyramids 2.3 Wavelet Transform 3. Colour Perception and Colour Spaces 4. Image Enhancement <ol style="list-style-type: none"> 4.1 Point Operations 4.2 Linear Filtering 4.3 Wavelet Shrinkage, Median Filtering, M-Smothers 4.4 Mathematical Morphology 4.5 Diffusion Filtering 4.6 Variational Methods 4.7 Deblurring 5. Feature Extraction <ol style="list-style-type: none"> 5.1 Edges

	<ul style="list-style-type: none"> 5.2 Corners 5.3 Lines and Circles 6. Texture Analysis 7. Segmentation <ul style="list-style-type: none"> 7.1 Classical Methods 7.2 Variational Methods 8. Image Sequence Analysis <ul style="list-style-type: none"> 8.1 Local Methods 8.2 Variational Methods 9. 3-D Reconstruction <ul style="list-style-type: none"> 9.1 Camera Geometry 9.2 Stereo 9.3 Shape-from-Shading 10. Object Recognition <ul style="list-style-type: none"> 10.1 Eigenspace Methods 10.2 Moment Invariances
Assessment / Exams:	<ul style="list-style-type: none"> • Regular attendance of classes and tutorials. • At least 50% of all possible points from the weekly assignments have to be gained to qualify for the final exam. • Passing the final exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer
Literature:	<ul style="list-style-type: none"> • R. C. Gonzalez, R. E. Woods: Digital Image Processing. Addison-Wesley, Second Edition, 2002. • K. R. Castleman: Digital Image Processing. Prentice Hall, Englewood Cliffs, 1996. • R. Jain, R. Kasturi, B. G. Schunck: Machine Vision. McGraw-Hill, New York, 1995. • R. Klette, K. Schlüns, A. Koschan: Computer Vision: Three-Dimensional Data from Images. Springer, Singapore, 1998. • E. Trucco, A. Verri: Introductory Techniques for 3-D Computer Vision. Prentice Hill, Upper Saddle River, 1998.

Program of Studies:	Master Program CCT
Name of the module:	Embedded Systems
Abbreviation:	ES
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Reinhard Wilhelm
Lecturer(s):	Prof. Dr. Reinhard Wilhelm, Dipl.-Ing. Stephan Thesing
Language:	English
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) The course is accompanied by a laboratory project, in which a non-trivial embedded system has to be realized.
Total workload:	270 h = 90 h classes and 180 h private study
Credits:	9
Entrance requirements:	The students should learn methods for the design, the implementation, and the validation of safety-critical embedded systems.
Aims / Competences to be developed:	The students should learn methods for the design, the implementation, and the validation of safety-critical embedded systems.
Content:	<p>Embedded Computer Systems are components of a technical system, e.g. an air plane, a car, a household machine, a production facility. They control some part of this system, often called the plant, e.g. the airbag controller in a car controls one or several airbags. Controlling means obtaining sensor values and computing values of actuator signals and sending them.</p> <p>Most software taught in programming courses is transformational, i.e. it is started on some input, computes the corresponding output and terminates. Embedded software is reactive, i.e. it is continuously active waiting for signals from the plant and issuing signals to the plant.</p> <p>Many embedded systems control safety-critical systems, i.e. malfunctioning of the system will in general cause severe damage. In addition, many have to satisfy real-time requirements, i.e. their reactions to input have to be produced within fixed deadlines.</p>

	<p>According to recent statistics, more than 99% of all processors are embedded. Processors in the ubiquitous PC are a negligible minority. Embedded systems have a great economical impact as most innovations in domains like avionics, automotive are connected to advances in computer control. On the other hand, failures in the design of such systems may have disastrous consequences for the functioning of the overall system. Therefore, formal specification techniques and automatic synthesis of software are used more than in other domains.</p> <p>The course will cover most aspects of the design and implementation of embedded systems, e.g. specification mechanisms, embedded hardware, operating systems, scheduling, validation methods.</p>
Assessment / Exams:	<ul style="list-style-type: none"> • Written exam at the end of the course. • Demonstration of the implemented system. • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Slides, beamer, blackboard, computer labs
Literature:	<ul style="list-style-type: none"> • Peter Marwedel: Embedded System Design, Kluwer, 2003 • Gorgio Buttazzo: Hard Real-Time Computing Systems, Springer, 2005 • Heinz Wörn, Uwe Brinkschulte: Echtzeitsysteme, Springer, 2005

Assessment / Exams:	Oral exam 30 minutes
Used Media:	Slides, White Board
Literature:	<ul style="list-style-type: none"> • Richard O. Duda, Peter E. Hart, David G. Stork , Pattern Classification, Wiley-Interscience , November 2000 • Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, Spoken Language Processing, Prentice Hall • Ernst Günter Schukat-Talamazzini, Automatische Spracherkennung, Vieweg Verlag, Braunschweig/Wiesbaden 1995

Program of Studies:	Master Program Computer Science
Name of the module:	Operating Systems
Abbreviation:	OS
Subtitle	
Modules:	Lecture 4 h (weekly) Tutorial 2 h (weekly)
Semester:	1 st -3 rd Semester / At least once every two years
Responsible lecturer:	Prof. Dr. Helge Scheidig
Lecturer(s):	Prof. Dr. Helge Scheidig
Language:	German
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 4 h (weekly) Tutorial 2 h (weekly) Tutorials in groups of up to 20 students
Total workload:	270 h = 90 h of classes and 180 h private study
Credits:	9
Entrance requirements:	
Aims / Competences to be developed:	Knowledge of fundamental characteristics of operating systems
Content:	<ul style="list-style-type: none"> • development • Tasks and organisation forms • Processes: general characteristics, synchronization • Processes: implementational characteristics, • interruption systems • operating equipment • scheduling • main storage maintenance • message exchange, procedural and message oriented operating systems, • structuring operating systems • modelling asynchronous processes through petri-networks, • dealing with deadlocks, security • coordination in systems for computer aided group work, • coordination of multimedia streams in multimedia systems
Assessment / Exams:	Regular attendance of classes and tutorials Passing 2 written exams (midterm and final exam) A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Used Media:	Slides
Literature:	Updated list at the beginning of each semester A. Tanenbaum: Operating Systems (Design und Implementation), Prentice Hall, 1995)

Program of Studies:	Master Program CCT
Name of the module:	Computational Electromagnetics 1
Abbreviation:	CE I
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	
Responsible lecturer:	Prof. Dr. R. Dyczij-Edlinger
Lecturer(s):	Prof. Dr. R. Dyczij-Edlinger
Language:	German
Level of the unit / mandatory or not:	Undergraduate course / Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	Recommended: a first course in electromagnetic fields (Theoretische Elektrotechnik 1)
Aims / Competences to be developed:	<ul style="list-style-type: none"> • Selected topics in numerical linear algebra. • Well-posed formulation of linear (initial-) boundary value problems of classical electrodynamics. • Numerical solution by differential and integral equation methods.
Content:	<ul style="list-style-type: none"> • Numerical linear algebra: eigenvalue-, singular value, QR and LR decompositions, sparse matrices, Krylov subspace methods. • Linear (initial-) boundary value problems of classical electrodynamics: well-posed and ill-posed problems, elliptic, parabolic, hyperbolic and unclassified operators. • Numerical methods: consistency, stability, convergence. • Finite difference method, finite integration technique: discretization, initial and boundary values, explicit and implicit time integration methods, stability analysis. • Finite element method: variational method, Euler-Lagrange equations, essential and natural boundary values, Ritz method, method of weighted residuals, collocation, Galerkin, Galerkin-Bubnow, discretization, shape functions, element matrices, implementation of boundary values and sources. • Boundary element method: Green's function, integral equations, classification, discretization, singularities.

Assessment / Exams:	<ul style="list-style-type: none"> • 50% from demonstrating and explaining programming projects in MATLAB during the semester. • 50% from written final exam offered three times a year.
Used Media:	<p>Beamer, blackboard.</p> <p>Lecture notes, project assignments, old exams, and selected solutions available at www.lte.uni-saarland.de/german/teaching/classes.html</p>
Literature:	<p>Numerical linear algebra:</p> <ul style="list-style-type: none"> • Demmel: Applied Numerical Linear Algebra. • Trefethen, Bau: Numerical Linear Algebra. <p>Numerical solution of partial differential equations:</p> <ul style="list-style-type: none"> • Strauss: Partial Differential Equations: An Introduction. • Kreyszig: Introductory Functional Analysis with Applications. • Courant, Hilbert: Methoden der mathematischen Physik. • Stakgold: Green's Functions and Boundary Value Problems. • Strang, Fix: An Analysis of the Finite Element Method. • Grossmann, Roos: Numerik partieller Differentialgleichungen.

Program of Studies:	Master Program CCT
Name of the module:	Electronics III (High-Speed Analogue Circuit Design)
Abbreviation:	E III
Subtitle	
Modules:	Lecture 2h (weekly) Tutorial 1h (weekly)
Semester:	1 st -3 rd Semester, at least once every two years
Responsible lecturer:	Prof. Dr. M. Möller
Lecturer(s):	Prof. Dr. M. Möller
Language:	German and English mixed
Level of the unit / mandatory or not:	Graduate course / Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1h (weekly)
Total workload:	135 h = 42 h classes and 93 h private study
Credits:	4,5
Entrance requirements:	Bachelor level in Electronics and Circuits (Elektronik I and II)
Aims / Competences to be developed:	To know and understand limitations on maximum speed and performance of integrated circuits. To know and to be able to apply design methods and concepts to enhance speed and performance of a circuit. To be familiar with basic circuit stages and methods for combining them to gain a specific functionality and performance. To understand basic circuit concepts for high-speed data- and signal-transmission and –processing with special regard to the transmitter- and receiver-electronics. To be able to design such circuits. To acquire the fundamentals of circuit design as a preparation for the related hands-on training on “High-speed analogue circuit design”.
Content:	<ul style="list-style-type: none"> • Bipolar transistor model and properties at technological speed limit. • Concept of negative supply voltage and differential signalling. • Method of symbolic calculation and modelling of transistor stages. • Basic electrical properties of transistor stages with special regard to high-frequency considerations. • Concept of conjugate impedance mismatch. • Functional stages for broadband operation up to 160 Gbit/s (e.g. photodiode–amplifier, modulator driver, linear and limiting gain stages and amplifier, circuits for gain control, equalizing and analogue signal processing, Multiplexer, Demultiplexer, logic gates(e.g. exor), phase detector, Oscillator (VCO), phase-locked-loop (PLL)).

Assessment / Exams:	Theoretical and practical (CAD examples) exercises <ul style="list-style-type: none"> • Regular attendance of lecture and tutorial • Final oral exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Beamer, blackboard, lecture notes, Computer (CAD examples)
Literature:	<ul style="list-style-type: none"> • Lecture notes • High Speed Integrated Circuit Technology Towards 100 GHz Logic, M. Rodwell, World Scientific • Intuitive Analog Circuit Design, Marc T. Thompson, Elsevier 2006 • Related articles from journals and conferences.

Program of Studies:	Master Program CCT
Name of the module:	Electronics IV (Basic Methods for Characterization and Optimization of High-Frequency Electrical Networks)
Abbreviation:	E IV
Subtitle	
Modules:	Lecture 2h (weekly) Tutorial 1h (weekly)
Semester:	1 st -3 rd Semester, at least once every two years
Responsible lecturer:	Prof. Dr. M. Möller
Lecturer(s):	Prof. Dr. M. Möller
Language:	German and English mixed
Level of the unit / mandatory or not:	Graduate course / Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1h (weekly)
Total workload:	135 h = 42 h classes and 93 h private study
Credits:	4,5
Entrance requirements:	Bachelor level in Electronics and Circuits (Elektronik I and II)
Aims / Competences to be developed:	Acquiring basic knowledge on fundamental high-frequency and network-theory methods to characterize and model distributed and lumped element networks. Applying these methods to modelling, design and measurement of high-speed circuits. Introduction to general optimization criteria and optimization strategy. To prepare for hands-on training on "RF-circuits and measurement techniques".
Content:	<ul style="list-style-type: none"> • Introduction: Retardation, Skin-, Proximity-Effect, Signal path lengths, lumped and distributed properties, Interconnect and Transmission Line modelling • Waves and S-parameters: Generalised waves, power, reflection, Smith diagram, matching, S-parameters, ABCD-parameters, Signal flow graph methods. • Network properties: Tellegen theorem, linearity, reciprocity, symmetry, unitarity, modal network description (differential operation), • Network measurement methods and components: time domain reflectometry (TDR), line-coupler, power splitter/divider, Vector Network Analyzer (VNA) • Electrical Noise Noise processes, characterization and properties, network models

	<ul style="list-style-type: none"> • Optimization criteria (e.g. noise, phase- and frequency response, linearity, stability, matching CMRR, PSRR, pulse fidelity, eye-diagram) • Optimization strategy: Trade-off, degrees of freedom (DOF), Introducing DOFs by decoupling, optimization example
Assessment / Exams:	<p>Theoretical and practical (CAD examples) exercises</p> <ul style="list-style-type: none"> • Regular attendance of lecture and tutorial • Final oral exam • A re-exam takes place during the last two weeks before the start of lectures in the following semester.
Used Media:	Beamer, blackboard, lecture notes, Computer (CAD examples)
Literature:	<ul style="list-style-type: none"> • Lecture notes • Hochfrequenztechnik 2, Zinke, Brunswig, 5. Auflage, Springer • Microwave Engineering, David M. Pozar, 3rd ed., Wiley • Grundlagen der Hochfrequenzmesstechnik, B. Schiek, Springer • Rauschen, R. Müller, Springer • Related articles from journals and conferences.

Program of Studies:	Master Program CCT
Name of the module:	Pattern and Speech Recognition
Abbreviation:	PSR
Subtitle	
Modules:	Lecture 2h (weekly) Tutorial 1 h (weekly)
Semester:	1.-4. Semester /Every winter term
Responsible lecturer:	Prof. Dr. Dietrich Klakow
Lecturer(s):	Prof. Dr. Dietrich Klakow
Language:	English
Level of the unit / mandatory or not:	
Course Type / weekly hours:	Lecture 2h (weekly) Tutorial 1h (weekly) Tutorials in groups
Total workload:	
Credits:	4.5
Entrance requirements:	
Aims / Competences to be developed:	The core of any speech recognizer is a pattern classification system. In this course, we will cover the basic principles of pattern recognition and machine learning and see how they are applied to speech recognition.

Content:

- Bayes Classifier
- Normal Distribution
- Parameter Estimation
- Nearest Neighbor Classifier
- Gaussian Mixture Models
- Decision Trees
- Hidden Markov Models
- Acoustic Modeling
- Adaptation
- Search

Program of Studies:	Master Program CCT
Name of the module:	Statistical Natural Language Processing
Abbreviation:	SNLP
Subtitle	
Modules:	Lecture 2h (weekly) Tutorial 1 h (weekly)
Semester:	1.-4. Semester /Every summer term
Responsible lecturer:	Prof. Dr. Dietrich Klakow
Lecturer(s):	Prof. Dr. Dietrich Klakow
Language:	English
Level of the unit / mandatory or not:	
Course Type / weekly hours:	Lecture 2h (weekly) Tutorial 1 h (weekly) Tutorials in groups
Total workload:	
Credits:	4.5
Entrance requirements:	
Aims / Competences to be developed:	How does a search engine find the right web page? How can information be extracted from e-mails. The lecture will introduce statistical methods to process natural language. Also common themes like the design of classifiers will be treated.

Content:	<ul style="list-style-type: none"> • language processing: basic terms • mathematical foundations • text classification • word sense disambiguation • part-of-speech tagging • named-entity recognition • statistical methods in information retrieval • text classification
Assessment / Exams:	Oral exam 30 minutes
Used Media:	Slides
Literature:	Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: May 1999.

Program of Studies:	Master Program CCT
Name of the module:	Microelectronics 3
Abbreviation:	ME3
Subtitle	
Modules:	Lecture: 2 hrs Tutorial: 1 hr
Semester:	7th Semester / Winter semester
Responsible lecturer:	Prof. Dr.-Ing. Chihao Xu
Lecturer(s):	Prof. Dr.-Ing. Chihao Xu
Language:	German or English
Level of the unit / mandatory or not:	7. Semester, Elective
Course Type / weekly hours:	Lecture: 2 hrs Tutorial: 1 hr
Total workload:	60 hrs = 30 hrs of classes and 30 hrs private study
Credits:	4,5 LP
Entrance requirements:	Microelectronic 1+2
Aims / Competences to be developed:	- <i>Fundamental knowledge of analog IC</i> - <i>Design of analog and mixed-signal MOS Circuits</i>
Content:	- Fundamental of Analog Circuit Design: electronic devices, matching, parasitic Elements - MOS-Operation Amplifier, multistage, AC-Analysis, Noise, optimal Layout - Bandgap Reference Circuits - Sample & Hold Circuit - Switch-Capacitor-Filter - Analog/Digital- and Digital/Analog-Converter - PLL Circuit
Assessment / Exams:	- Regular attendance of classes and tutorials - Passing the final Exam
Used Media:	- Slides with Laptop and video projector
Literature:	- Script in German, can be downloaded. - P. E. Allen and D. R. Holberg. CMOS Analog Circuit Design. Holt, Rinehart and Winston, 1987. - P. R. Gray and R.G.Meyer. Analysis and Design of Analog Integrated Circuits. JohnWiley & Sons, 1984. - K. R. Laker and W. M. C. Sansen. Design of Analog Integrated Circuits and Systems. McGraw Hill, 1994. - R. L. Geiger, P. E. Allen, and N. R. Strader. VLSI Design

	<p>Techniques for Analog and Digital Circuits. McGraw Hill, 1990.</p> <ul style="list-style-type: none">- A. B. Grebene. Bipolar and MOS Analog Integrated Circuit Design. John Wiley & Sons, 1984.- P. Antognetti and G. Massobrio. Semiconductor Device Modelling with SPICE. McGraw Hill, 1988.- U. Tietze und C. Schenk. Halbleiter-Schaltungstechnik. Springer, 1990.
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Studiengang:	Master Program CCT
Modulbezeichnung:	Microelectronics 4
ggf. Kürzel	ME4
ggf. Untertitel	Mikroelektronische Applikationen und Systeme
ggf. Lehrveranstaltungen:	Vorlesung 2SWS
Semester:	Sommersemester
Modulverantwortliche(r):	Prof. Dr.-Ing. Chihao Xu
Dozent(in):	Prof. Dr.-Ing. Chihao Xu + Mitarbeiter des Lehrstuhls Mikroelektronik
Sprache:	Deutsch
Zuordnung zum Curriculum	8. Semester
Lehrform / SWS:	<i>Vorlesung 2SWS</i>
Arbeitsaufwand:	30WS Präsenz, 45WS für Vorbereitung/ Nachbereitung
Kreditpunkte:	
Voraussetzungen:	Hauptdiplom
Lernziele / Kompetenzen:	<p>Abwechselnd aus den folgenden Themenkreisen:</p> <ul style="list-style-type: none"> • Analoge und digitale Low-Power Low-Voltage Systems • Power Management (LDO, SMPS) • HV circuit (charge pump, level shifter, hv driver) • mechatronische Applikationen (Motorsteuerung, Ventiltreiber etc.) • Sensor readout circuitry (Druck, "Hall-Effekt") • Image Sensor Systeme (Photodiode, readout, image processing) • Display Treiber (LCD, TFT, OLED) • Verhaltensmodelle und Systemsimulation • SoC with embedded memory, NVM, processor, logic and mixed signal blocks (ADC, PLL etc.)
Inhalt:	
Studien-Prüfungsleistungen:	Projektarbeit in Zweiergruppen mit Abschlussvortrag
Medienformen:	Power-Point

Program of Studies:	Master Program CCT
Name of the module:	Computational Electromagnetics 2
Abbreviation:	CE 2
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	
Responsible lecturer:	Prof. Dr. R. Dyczij-Edlinger
Lecturer(s):	Prof. Dr. R. Dyczij-Edlinger
Language:	Students may choose between English and German
Level of the unit / mandatory or not:	Graduate course / Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	Recommended: Computational Electromagnetics 1
Aims / Competences to be developed:	Solid understanding of finite element methods for time-harmonic electromagnetic fields.
Content:	<ul style="list-style-type: none"> • Discrete differential geometry <ul style="list-style-type: none"> ○ De Rham complex and Whitney complex ○ Finite element function spaces and basis functions • Modal analysis of electromagnetic cavities <ul style="list-style-type: none"> ○ Theory of inhomogeneous cavities ○ Finite element formulations ○ Numerical techniques • Modal analysis of electromagnetic waveguides <ul style="list-style-type: none"> ○ Theory of inhomogeneous waveguides ○ Finite element formulations • Analysis of driven time-harmonic fields <ul style="list-style-type: none"> ○ Theory of driven time-harmonic fields ○ Generalized network theory ○ Finite element formulations ○ Special techniques: waveguide ports, radiating fields ○ Numerical techniques • Functional analysis <ul style="list-style-type: none"> ○ Advanced theory of finite elements
Assessment / Exams:	Student presentations of selected topics from current research papers.

Used Media:	Blackboard, beamer, slides
Literature:	<ul style="list-style-type: none">• Bossavit: Computational Electromagnetism, Academic Press, 1998.• A.C. Cangellaris, Y. Zhu: Multigrid Finite Element Method for Electromagnetic Field Modeling, John Wiley and Sons, 2006.• D. Davidson: Computational Electromagnetics for RF and Microwave Engineering, Cambridge Univ Press, 2005.• B.D. Reddy, Introductory Functional Analysis: With Applications to Boundary Value Problems and Finite Elements, Springer, 2004.• S. Brenner, R. Scott: The Mathematical Theory of Finite Element Methods, Springer, 2002.

Program of Studies:	Master Program CCT
Name of the module:	Computational Electromagnetics 3
Abbreviation:	CE 3
Subtitle	
Modules:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Semester:	2 nd – 4 th semester, at least once every other year
Responsible lecturer:	Prof. Dr. R. Dyczij-Edlinger
Lecturer(s):	Prof. Dr. R. Dyczij-Edlinger
Language:	Students may choose between English and German
Level of the unit / mandatory or not:	Graduate course / Mandatory Elective
Course Type / weekly hours:	Lecture 2 h (weekly) Tutorial 1 h (weekly)
Total workload:	135 h = 45 h of classes and 90 h private study
Credits:	4,5
Entrance requirements:	Recommended: Computational Electromagnetics 2
Aims / Competences to be developed:	Solid understanding of adaptive finite element methods, fast solvers, and formulations for quasi-static electromagnetic fields.
Content:	<ul style="list-style-type: none"> • Adaptive finite element methods <ul style="list-style-type: none"> ○ H refinement versus p enrichment ○ A posteriori error indicators and estimators ○ Marking strategies • Fast solvers <ul style="list-style-type: none"> ○ Direct methods: multifrontal solvers, reordering ○ Krylov subspace methods ○ Geometric multigrid solvers: basics, local multigrid ○ P multilevel and domain decomposition solvers: additive und multiplicative Schwarz methods, FETI • Time-dependent FE methods <ul style="list-style-type: none"> ○ Time-stepping schemes ○ Nonlinearities • Selected finite element formulations for quasi-static fields
Assessment / Exams:	Student presentations of selected topics from current research papers.
Used Media:	Blackboard, beamer, slides
Literature:	<ul style="list-style-type: none"> • M. Ainsworth, J.T. Oden: A Posteriori Error Estimation in Finite Element Analysis, J. Wiley and Sons, 2000.

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| | <ul style="list-style-type: none">• R. Verfürth: A Review of A Posteriori Error Estimators and Adaptive Mesh–Refinement Techniques, Teubner, 1998.• W.L. Briggs, H. van Emden, S.F. McCormick: A Multigrid Tutorial, 2nd edition. SIAM, 2000.• U. Trottenberg, C. Oosterlee, A. Schüller: Multigrid, Academic Press, 2001.• B. Smith, P. Bjorstad, W. Gropp: Domain Decomposition; Parallel Multilevel Methods for Elliptic Partial Differential Equations, Cambridge University Press, 1994.• Quarteroni, A. Valli: Domain Decomposition Methods for Partial Differential Equations, Oxford Science Publications, 1999.• W.L. Wood: Practical Time Stepping Schemes, Clarendon Press, 1990. |
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