Lectures in English at School of Electrical, Information and Media Engineering at the University of Wuppertal
Summer term 2021

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Microanalysis of Materi-als and Devices in Elec-tronics Dr. R. Heiderhoff	Within this course different methods by means of scanning microscopy techniques will be illustrated. Especially, the pos-sibilities for failure analyses as well as material characterisa-tion with sub-micron resolution will be discussed.	1. Basics 1.1. General principles of scanning microscopy tech-niques 2. Scanning Electron Microscopy 2.1. Generation of focused electron beamsworking function, operation modes, magnetic lenses, elec-tron beam parameters 2.2. Interaction of electrons with solidselastic and ine-lastic scattering, energy dissipation, penetration depth, secondary electrons and back scattered electrons, environmental mode, material and volt-age contrast, Bragg reflection 2.3. TEM (STEM)dark and bright field detection, elec-tron energy loss spectroscopy 2.4. Electron beam techniquescathodoluminescence, electron beam induced current, Auger electron spectroscopy, x-ray photoelectron spectroscopy 2.5. Modulation techniques 3. Scanning probe microscopy: 3.1. General principles 3.2. Scanning tunneling microscopy 3.3. Scanning force microscopy 3.4. Near-field scanning optical microscopy 3.5. Complementary scanning probe microscopy tech-niques Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Numerical Methods in Computational Engineering Dr. F. Kasolis (Prof. Dr. M. Clemens) (Lecture will be given in English if required)	Students will get in-depth knowledge about algorithms and numerical methods which are used in modern CAD-simulation tools of computational engineering. These methods are often used independent of the physical background of the simulation tool. Based on this knowledge the students will be enabled to correctly judge the capabilities and limits of computational engineering simulation tools. In addition, students will learn to include these methods correctly when designing their own proprietary simulation tools for Computational Engineering applications.	1. Methods of CAD-data exchange and automatic grid generation (of unstructured FEM-grids) 2. Numerical solution techniques for large algebraic systems of equations: 2.1. implicit/explicit time integration methods: (One-Step/Multistep methods, Runge-Kutta-Methods, BDF-formula, stability criteria, Stepp size selection) 2.2 Linear algebraic systems of equations: 2.2.1. direct methods (Gauss-/Choleski-methods; complexity; implementations) 2.2.2. iterative methods: Stationary methods (one-/multigrid-schemes, Algebraic Multigrid-schemes, subspace correction and domain Decomposition methods); Instationary methods (Method of Conjugate Gradients, Krylov-subspace methods, Arnoldi-/Lanczos-/Bi-Lanczos-methods and implementation, preconditioning techniques) 2.3 Nonlinear algebraic systems of equations: (Newton-Raphson-Method, Quasi-Newton-procedure, Picard-Iterations, Relaxation methods) 2.4 Solution methods for algebraic eigenvalue problems (QR-Iterations, Krylov-subspace method, Jacobi-Davidson-method) 3. Visualization techniques for numerical data fields Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Computational Electro-magnetics 1 Prof. Dr. M. Clemens	Getting an overview of an insight into various techniques to numerically simulate electromagnetic and coupled multiphysics field problems in highly complex technical systems or biological organisms.	Discrete electromagnetic field theory: Continuous geometric discretization methods for Maxwell's equations (Finite-Difference-Method, Finite Integration Technique, Cell Method, Whitney Finite Element Method), Discrete field formulations, implementations (commercial/research) and practical applications for electromagnetic/ multiphysical field problems in complex systems/biological organisms

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Organic Electronics Prof. Dr. T. Riedl	This lecture will provide an introduction to the emerging field of organic semiconductors and devices.	• Fundamentals of organic semiconductors - Materials (polymers, oligomers, dendrimers, small molecules) - Structural properties - Electronic properties - Optical properties • Technological aspects • Organic transistors • Organic memory • Large area electronics • Organic energy - Photovoltaics → Dye sensitized cells → Thin-film solar cells - Energy storage • Organic light emitting devices - OLEDs → General lighting → Displays - Organic Lasers • Market prospects for organic electronics Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Non-linear Control systems Prof. Dr. B. Tibken (in English upon arrangement)	The lecture deals with special problems of automatic control engineering, especially non-linear control systems.	1. Bilinear Systems 1.1. State space presentation Definition, examples, state vectors and system matrices 1.2. Direct bilinearization Derivation, error estimation 1.3. Carlemann linearization High-dimensional state space, universal approximation 1.4 Linear Systems with non-linear measuring equation introduction of multi indices, application of the Carlemann Linearization 2. Solving of state equations 2.1. Bilinear Systems Scalar bilinear systems, general bilinear systems 2.2 State transformation drawing up of the transition matrix, system transformation 2.3 Special cases commutating system matrix, triangular matrices 2.4 Volterra series modification of bilinear systems, convergent majorant (lecture will be continued, table of contents not complete) Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Information Retrieval Prof. Dr. B. Gipp	The need to organize vast amounts of information for effective retrieval long predates computers. Traditional libraries were the birthplace for many techniques to effectively organize and retrieve information. The introduction of computers redefined our methods of storing, accessing and searching for information and gave rise to a new research field – Information Retrieval. The diversity of information on the World Wide Web introduced new retrieval tasks, which triggered the advancement of traditional and the creation of new information retrieval technologies. This course introduces core concepts and technologies of both traditional information retrieval as well as information retrieval on the Web. The course will introduce important retrieval tasks, such as Web search and document recommendation and demonstrate the application of information retrieval concepts and technologies to fulfil the information needs of the stakeholders involved.	The lecture will cover the following topics: - Basics: background, documents, terms, vocabulary, inverted index - Boolean retrieval, positional retrieval, tolerant retrieval - Efficient index construction, index compression - Term weighting, relevance scoring, ranked retrieval - Semantic text analysis, link analysis-complete retrieval systems - Results visualization and exploration - Evaluation of retrieval systems The exercise sessions will mix assignments and a comprehensive applied research project. The assignments will consolidate the key concepts introduced in the lecture. The applied research project will address a complex information retrieval task, such as: - crawling and traversing Web pages - scraping HTML pages, forms, or JavaScript - parsing and processing natural language from large data sets (e.g. Twitter or Wikipedia) - cleaning, extracting, transforming, and storing information The programming language Python will be used. Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Applied Machine Learning Prof. Dr.-Ing. T. Meisen (Lecture will be given in English if required)	This lecture deals with the basic methods of machine learning and their application. Students will learn about supervised and unsupervised learning methods as well as reinforcement learning. The methods are introduced and discussed on the basis of practical examples, so that not only the theoretical basics but also the limits and applicability are addressed. The methods are implemented in Python applications during the exercise.	The lecture will cover the following topics: ▪ Supervised Learning ○ Regression ○ Artificial Neural Networks ○ Support Vector Machines ○ Nearest-Neighbor-Classification ○ Tree-based Classification ▪ Unsupervised Learning ○ Clustering (data-based, density-based, hierar-chical) ○ Principal Component Analysis ○ Other methods of dimensionality reduction ▪ Reinforcement Learning ○ Introduction to basics of reinforcement learning ○ (Deep) Q-Learning Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**

Deep Learning
 	
Prof. Dr.-Ing. T. Meisen
 	
(Lecture will be given in English if required)
	Students gain in-depth knowledge of how modern machine learning methods work, with a special focus on deep learning.
	
	They are familiar with the functionality of different architectures of artificial neural networks and know the suitable applications of the respective architecture types. They get to know modern and advanced concepts for the training of complex architectures and are able to design suitable models and training methods for new problems.
	
	Furthermore, they are familiar with the concepts of implementing these methods and are able to develop complex deep learning applications with the Deep Learning Framework PyTorch.
		The lecture will cover the following topics:
		
		▪ Introduction to Deep Learning
		▪ The History of Deep Learning
		▪ (Deep) Neural Networks
		    ○ Mathematical building blocks of neural networks
		    ○ Training of neural networks
		▪ Computer Vision
		    ○ Convolutional Neural Networks
		    ○ R-CNN, Fast-R-CNN, Faster-R-CNN, YOLO
		    ○ Practical applications of Convolutional Neural Networks
		▪ Natural Language Processing: Deep Learning for Text and Language
		    ○ Recurrent Neural Networks
		    ○ Long-Short-Term Memory Networks
		    ○ One-Hot-Encoding and Word2Vec
		    ○ Practical applications of Recurrent Neural Networks
		▪ Deep Reinforcement Learning
		
		Credits: 6

Title of lecture **Name of lecturer**	**Purpose of the lecture**	**Detailed description**
Integrated Circuits for Communications – ICC Prof. Dr. U. Pfeiffer	The students will learn how to design full-custom radio frequency and mm-Wave integrated circuits based on today's advanced nano-scale semiconductor technologies (SiGe HBTs and CMOS). The lecture covers basic knowledge in circuit design for radio frequencies as well as practical exercises with industry-standard IC design software (Cadence).	Review of MOS and BJT technologies for high-speed applications, FET small-signal model, important device parameters, transconductance, unity-gain-frequency, bipolar small-signal model, bipolar unity-gain-frequency, high-speed amplifiers and two-port design, RLC-networks, Q-factors, tuned amplifiers, general properties of two-port networks, two-port networks, S Y H G parameters, input/output Admittance of two-ports, series feedback, course work introduction, power gain definitions, stability, k-factor, circuit design project description, simultaneous conjugated match, maximum power gain definitions, Cadence software introduction, impedance matching networks, L-Sections, T-Sections, Pi-Sections, harmonic distortion, project work, inter-modulation distortion, distortion, HD2, HD3, THD, IM2, IM3, IP2, IP3, P1dB, BJT example, electronic noise, Johnson-noise, Spot-Noise, available-noise power, Shot-noise, BJT/FET equivalent noise model, SNR, noise-figure, noise-factor, NF, BJT noise sources, optimum source resistance, Fmin, BJT NF, noise correlation, FET noise figure, design of LNA, mixer, image problem/rejection, direct conversion, I/Q-modulators Credits: 6