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

Winter term 2021/2022

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Reliability of electronic devices and systems Dr. R. Heiderhoff	Within this lecture measurement as well as S/N recovery methods working in time, frequency, and modulation domains will be presented and discussed with respect to their applicability	1. Introduction 1.1 Detection of signals within different measurement domains (Time Domain, Frequency Domain, Modulation Domain) 1.2 Noise sources, noise figures (1/f, Schot noise, thermal noise) and S/N 1.3 Description and determination of life times and failure distributions of electronic devices (Weibull statistic) 2. Measurement and signal recovery of electrical signals 2.1 Sampling-Techniques / Mixing Techniques 2.2 S/N improvement: Lock-In-Amplifier Dualphase, Heterodyn (VCO)), 2.3 Time resolved measurements of fast signals in time domain: Averaging (Boxcar-Integrator, sampling heads), (Single event multichannel Oscilloscope) 2.4 Measurements in Frequency Domain (Spectrum Analyser, Network Analyser) S-Parameter 3 Reliability investigations by use of optical radiation 3.1 Photon Emission Microscopy (Photo Detectors (PMT (Photo-cathodes, QE, Dark-current), CCD) 3.2 Generation of short laser-pulse and its characterization (correlation technique (Streak-Camera, Optical Auto-Correlation)) 3.3 Optical Testing (Electro-Optic Sampling (Kerr-effect), Optical Beam Induced Resistance Change (OBIRCH), Thermally Induced Voltage Alteration (TIVA) Picosecond Imaging Circuit Analysis (PICA) Credits: 6

Title of lecture Name of lecturer	Purpose of the seminar	Detailed description
Computational Electromagnetics 2 Prof. Dr. M. Clemens	Within small project teams, students will learn within small industry style" projects given to them to effectively use modern (preferably industrial standard) commercial CEM simulation tools or to alternatively develop and use own implementations of electromagnetic field simulators. They will learn to use these tools to describe and possibly optimize the electromagnetic properties of devices and systems in electrical engineering applications of science and industry. The results of their CEM simulation project work are to be presented in oral and scientific report form.	Team work on industry style projects including commercial electromagnetic field simulations tools (e.g. CST Suite, SEMCAD, FEKO, COMSOL) and/or custom made implementations of simulation tools. Projects goals and the selection of the CEM simulation tools may vary depending on the devices /systems to be modelled. Team presentation of project results within two oral project presentations (first mid semester, second at end of semester) and a written scientific report (paper) to be handed in at the end of the semester. Credits: 8

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Optical Imaging and Sensing – OIS Dr. J. Grzyb	In this course, students will be taught in the mathematical modeling of optical systems and their use in imaging applications. Students acquire in-depth knowledge for research and development.	1. Maxwell equation and waves 2. Geometrical imaging 3. Optical elements 4. Focal imaging 5. Projection tomography 6. Wave imaging 7. Wave propagation 8. Diffraction 9. Wave analysis of optical elements 10. Fourier analysis of imaging 11. Coherent imaging 12. Optical coherent tomography 13. Radiometry, sources for imaging (optical/electronic) 14. Thermal sources, Plank black-body-radiation, matter waves 15. Imaging: X-rays, optical, thermal, THz-waves, microwaves, atmospheric absorption 16. Antenna theory, directivity, gain, efficiency, radiation pattern 17. Friis formular, pathloss 18. Radar equation, radar cross-section 19. Imaging detectors (optical/electronic) 20. Photoconductive/photovoltaic detectors 21. Square-law detectors, heterodyne receivers, resistive mixers, dristributed resistive mixers 22. Electronic noise, thermal noise, shot noise, 1/f noise 23. Imaging SNR, responsivity, noise-equivalent power, noise figure 24. Radar, pulsed radar, CW radar, FMCW radar, range resolution, ambiguity function, phased arrays, radar for 3D imaging 25. Image sampling, image examples 26. THz tomography, radon transformation, algorithm examples Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Electromagnetic Compatibility in Technical Systems Prof. Dr. M. Clemens (Lecture will be given in English if required)	This learning module aims at introducting the basic fundamentals of electromagnetic compatibility of technical systems. Students will learn about definitions and fundamental concepts of electromagnetic compatibility, electromagnetic interference and different electromagnetic environments. This also includes various typical emission sources and coupling mechanisms, examples of electromagnetic environments, filtering techniques, grounding techniques (earth ground, signal ground), emission reduction and shielding techniques. Examples of electromagnetic compatibility problems of technical systems will be given with respect to coupling paths and interference reduction techniques. Students will also be introduced into contemporary techniques of computational electromagnetic compatibility testing and their relevance to virtual prototype design with respect to electromagnetic compatibility.	Concepts, definitions and technical terms, various emission sources, coupling paths (conductive, capacitive, inductive, electromagnetic coupled systems), filter components, shielding, practical electromagnetic compatibility problems, fundamentals and techniques of computer-aided emc testing Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Optimization for Control Prof. Dr. B. Tibken (in English upon arrangement)		Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Energy Efficiency I Prof. Dr. B. Schmülling (in English upon arrangement)	The Students will get basic knowledge on methods and business models concerning the reduction of commercial, industrial and private energy consumption due to economic and/or ecologic reasons. Furthermore, skills on governmental steering mechanisms for an increase of energy efficiency and for a decrease of energy consumption are imparted.	- Definitions and basics of energy efficiency measures - Contracting o Power consumption analysis and estimation of the potential of the reduction of power consumption o Power cost vs. energy cost o Concepts for the reduction of cost and consumption - Technical facility management o Building automation o Redundancy - Energy consumption in industrial production o Assessment of energy efficiency measures o Optimization of energy efficiency of process chains - Energy consumption in transport applications o Assessment of energy consumption of different transport/mobility technologies - Governmental measures to increase the efficiency o Energy-performance labeling Credits:3

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Computer Graphics Prof. Dr.-Ing. R. Möller (in English upon arrangement)	This course mediates special knowledge in the area of automation/process informatics. Elementary courses in computer architecture and programming are preliminaries.	1. **Introduction** Definitions, Terms 2. **Basic elements of computer graphics** Raster image generation, Systems and hardware architectures, Human-machine interface 3. **Mathematical elements of computer graphics** Coordinate systems and transformations, Clipping, Hidden surface removal, Curves and surfaces 4. **Reality with computer graphics** Colour, Illumination modelling, Fractals and graphtals, Texturing, Stereo-imaging 5. **Computer graphics and applications** Computer Aided Design (CAD), Standards, Application areas Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Multimodal Human-Computer Systems Prof. Dr.-Ing. R. Möller (in English upon arrangement)	This course mediates special knowledge in the area of automation/process informatics. Elementary courses in computer architecture and programming are preliminaries.	1. **Introduction** Definitions, Terms 2. **MMMS Definitions and Standards** Ergonomy, Anthropometry, Information Management, Control Stations, Simulation, Cognition, Usability 3. **Graphical Systems** **Principles:** Raster Images, Device Architectures, Coordinate Systems and Transformations, Windows / Clipping, Colour; **Input/Output Systems**: Devices, Interaction Technologies; **Dialog Systems**; **Visual Systems** 4. **Speech Technology** Principles, Voice Recognition, Speaker Recognition, Speech Synthesis, Speech Control, Dialog Systems, Software- und Devices 5. **Virtual and Augmented Reality** **Principles**; **Systems Technology:** Displays, Tracking-Systems, Input Systems; **Standards; Applications:** Virtual Environments, Augmented Reality 6. **Haptics and Olfactory** **Elements**; **Consumer Technology** 7. **Biometrical Systems** **Definition; acoustical methods:** voice recognition, speech templates; **optical methods:** human characteristics, signature; **further methods:** force templates, movement, combined methods Credits: 5

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Multidimensional Signals and Systems Dr. J. Velten (Lecture will be given in English if required)	Introduction to multidimensional signals and systems theory. Applications: Image processing, Tomography, Virtual Reality.	**1** Multidimensional signals in time- and frequency domain **1.1** Multidimensional signals in time domain Special multidimensional continuous and discrete signals, multi-dimensional linear sampling **1.2** Multidimensional signals in frequency domain Periodic signals / Fourier series, multidimensional Fourier transform, multidimensional z-transform, sampling and sam-pling theorem, linear transforms **2** Multidimensional linear systems **2.1** k-D linear constant continuous-time systems Transfer function, impulse response, causality, stability **2.2** k-D linear constant discrete-time systems Transfer function, impulse response, causality, stability **2.3** Systems, described by linear difference equations with constant coefficients Causality, computability, general mode of operation, transfer function **2.4** Multidimensional networks, filters und digital filters Representation, attenuation and phase, FIR filter, IIR filter / wave digital filters, **3** Application of multidimensional signal processing **3.1** Medical applications, tomography Fourier-Slice theorem, Radon transform, filtered backpropagation **3.2** Information technology and multimedia applications, im-age processing Edge detection, filtering, morphological operations **3.3** Geophysics, waves Velocity filtering, DOA **3.4** Virtual reality Databases, geometric transforms, homogeneous coordinates, rendering, texture mapping Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Information Technology Prof. Dr. A. Kummert (Lecture will be given in English if required)	Introduction to signal processing by means of linear electrical two-ports, filter technology, transmission channels, matched filter, source coding	1 Electrical Two-Ports / Filters: Scattering parameters; Lossless filters based on two-ports; Classification; Realization of transfer functions; Attenuation; Normalization of building elements; Low pass filters (Butterworth low pass, Tschebycheff low pass, Elliptical low pass); High pass filter; Band pass filter; Band stop filter; Filter design 2 Noise Signals: Introduction; Thermal noise of resistors; Noise figures; Effective noise band width 3 Transfer Channel: Transfer rate; Channel capacity 4 Matched Filter: Cauchy-Schwarz inequality; System response; Signal detection; Pulse shape; Decision receiver 5 Source coding: Linear quantization; Redundancy and irrelevance; Prediction method; Transform coding (Introduction; Generalization; Karhunen-Loeve-Transform); Optimal coding Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Applied Natural Language Processing and Text Mining Prof. Dr. B. Gipp	The course participants will acquire the knowledge and skills necessary to visualize a wide range of data for analysis, exploration, and information purposes. The participants will learn the fundamentals of human perception, design and interaction principles as well as elemental visualization techniques necessary to create visualizations suitable for the given type of data and the intended use case. The participants will also know the requirements that different data types and levels of complexity impose on the visualization as well as how to evaluate the quality of information visualizations. Much of the data covered in the course is abstract, i.e., the data has no spatial reference and thus cannot be mapped trivially to geometric visuals. Examples of abstract data include survey results, database contents, or genome information. The participants will be challenged with data from many more applications in industry, business, science and everyday life.	The lecture will cover the following topics: • Introduction Course structure, schedule, projects, requirements, specifics; Course topics, motivation; Overview of the field • Text representation • Word embeddings and dense vector representations • Applications Participants (teamwork is possible) will carry out an applied research project that addresses complex NLP downstream tasks and subtasks, such as: • Word similarity • Document and Sentence classification • Named entity recognition • Question and answering system • Text summarization • Objective and subjective classification • Sentiment analysis • Part-of-speech tagging • Compositional knowledge entailment (entailment, contradiction, neutral) • Relation extraction and parsing • Machine translation The programming language Python will be used. Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Key Competences in Computer Science Prof. Dr. B. Gipp	Course participants will gain an overview of the state-of-the-art technologies and tools in computer science. Through lectures, exercises and individual work, students will train their ability to: - analyze a given problem from a computing perspective; - research programmatical methods to solve the problem; - implement a solution for the problem using suitable tools; - structure, write, and format documentation for the software developed; - present their work using appropriate presentation techniques and presentation aids; - answer questions and discuss their work with peers. Through extensive practical work on projects, students will dive deeper into selected topics and technologies and acquire essential skills necessary to solve applied research problems in computer science. By completing the course, participants will acquire the knowledge and the skills required to perform research in computer science and to complete a broad range of applied problems related to the computer science field.	The lecture will cover the following topics: Command-line & Scripting - shell, ssh, sftp - grep, sed, regular expressions, - shell scripting Python Programming - Python basics - unit testing - logging - parallelization - database interaction Web Technologies - Django Web framework - HTML & CSS - JavaScript Infrastructure & Support Tools - IDEs - version control using git - automated unit testing using Travis - LaTeX, OverLeaf - reference management tools 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 (see component B) will address a current problem in computer science. Credits: 6