Lectures in English at School of Electrical, Information and Media Engineering at the University of Wuppertal
Winter term 2023/2024

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, SEM-CAD, 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**
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 sampling 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, image 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
Theoretical Foundations of Applied Cryptography Prof. Dr.-Ing. T. Jager	**Students gain in-depth knowledge of classical security models and techniques for formal security analysis.**	New technologies such as Cloud Computing, Big Data, Industry 4.0, and the Internet of Things not only bring with them a great need for practical and efficient cryptosystems, but also many new types of attack vectors. The security properties required here go far beyond classical security goals. While theoretical cryptography provides techniques that enable the design and precise formal security analysis of cryptosystems in theoretical security models, many requirements of modern applications are not yet covered. An important current research topic is therefore to close this gap and to further develop the existing techniques in such a way that they better reflect the requirements of real applications. This lecture first gives an introduction to "provable security". Classical security models and techniques for formal security analysis are presented and then analyzed to what extent requirements of modern applications are met. Based on this, more realistic security models are developed and real-world constructions are presented and examined as examples. Credits: 6

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Advanced Mathematics (Mathematik C) Dr. Wyss	The students learn advanced mathematical methods and how to use them in applications. They acquire the mathematical knowledge that is required for other advanced lectures.	The lecture comprises the following topics: • vector calculus, theorems of Gauss and Stokes • complex analysis • differential equations: linear systems, introduction to partial differential equations • integral transforms: Laplace and Fourier transform Credits: 10 LP

Title of lecture Name of lecturer	Purpose of the lecture	Detailed description
Terahertz Electronics and Photonics Dr. Jagtap	Students will gain core interdisciplinary knowledge in the field of electronics and photonics towards realizing modern Terahertz systems. Students will acquire the fundamental understanding of the working principles of the electronic-photonic devices and are able to describe them quantitatively. After the successful completion of the course, students will be able to apply concepts in developing industrial terahertz systems.	This course is divided into the following four sections. 1. Building blocks of THz frequency synthesis: Rectification process and its implications on electronic and photonic transport properties; Fourier analysis of rectification, Semiconductor band structure introduction, artificial bandgap nano-engineering in generated semiconductor heterostructures, electron transports (junction, interband-, intraband-, intersubband- transitions), introduction to transistors and their multi-functions. 2. Principles of Terahertz generation: Electronic sources - Transistors as a THz frequency synthesizer -> harmonic generators, oscillators; Photonic sources - THz lasing in semiconductor heterostructures -> quantum cascade lasers; Optoelectronic source – Thz photomixing. 3. Principles of Terahertz detection: radiation coupling, Terahertz wave propagation, detector figures of merits, direct detection, heterodyne detection. 4. Defining Terahertz systems specifications: broadband vs narrowband, active vs passive, frequency domain vs time domain, coherent vs incoherent, power vs field, far-field vs near-field, Terahertz Imaging examples, Terahertz spectroscopy examples, Terahertz communications examples. Credits: 6 LP