COURSE DESCRIPTIONS

EEE DEPARTMENT THIRD CYCLE COURSE DESCRIPTIONS

(2015)

First year

Elective courses

EEE603. Special topics in biomedical signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Continuous-time and discrete-time application of signal processing tools to a variety of biomedical problems. Course topics include review of linear signals and systems theory, frequency transforms, sampling theorem, basis functions, linear filtering, feature extraction, parameter estimation and biological system modeling. Special emphasis will be placed on signal transduction and data acquisition. Additional topics include noise analysis of real-world biosignals, biological system identification, stochastic/chaotic/ fractal/nonlinear processes in biological systems. Concepts learned in class will be applied using software tools to 1D biomedical signals such as biological rhythms, chemical concentrations, blood pressure, speech, EMG, ECG, EEG.

EEE604. Special topics in biomedical image processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces the image Formation of various medical imaging modalities followed by engineering techniques widely utilized to accomplish image enhancement, image restoration, morphological image processing, image segmentation, feature recognition & classification and image visualization. Examples are drawn from various medical images for demonstration purpose.

EEE611. VLSI in signal processing and communications
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course offers a review of basic concepts in digital signal processing, followed by VLSI design methodologies, VLSI DSP building blocks. Attention is given to algorithm transformation and mapping techniques, high-speed, low-power transforms, applications to digital filtering. In terms of DSP implementation platforms, programmable DSPs, media processors, FPGAs, ASICs are covered. Some case studies of multimedia communications systems, video codecs, xDSL and cable modems are given as an illustration.

EEE612. Advanced CMOS VLSI design
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course covers design of Very Large Scale Integration integrated systems. The basics are covered through examination of layout and simulation of digital VLSI circuits using a comprehensive set of CAD tools in a laboratory setting. Fundamental structures of the layout of registers, adders, decoders, ROM, PLA's, counters, RAM, and ALU are given in an advanced fashion. Brief overview of application of statistics and probability to chip

performance is given, while CAD tools allow logic verification and timing simulation of the circuits designed.

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EEE613. Advanced HDL based systems design
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course revises hardware description languages, giving an overview of VHDL and Verilog, levels of abstraction for the description of the hardware. It focuses on programmable logic devices, combinational and sequential logic design using HDL, design of a CPU and its peripherals units, as well as implementation of various communication interfaces, test-bench generation. Finally, attention is given to synthesis and optimization of digital systems.

EEE621. High power microwave devices
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The course opens with a review of microwaves, waveguides, and transmission lines. Principles of high-power microwave generators like electron radiation, magnetic focusing, cathodes, electron guns and electron beams are introduced before typical microwave tubes: Klystrons, TWTs, crossed-field tubes, gyrotrons, vircators. Applications of high power microwave systems are analyzed thoroughly, such as radars, modification of the atmosphere, directed energy weapons.

EEE622. Special topics in microwave electronic circuits
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course reviews microwave circuit analysis and design techniques, followed by properties of planar transmission lines for integrated circuits. Matrix and computer-aided methods for analysis and design of circuit components are introduced and implemented. Their applicability is shown through analysis and design of input, output, and interstage networks for microwave transistor amplifiers and oscillators. Besides these methods, attention is put on topics on stability, noise, and signal distortion as well.

EEE631. Stochastic signals and systems I
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After an overview of the meaning and axioms of probability, conditional probability, this course introduces combined experiments, Bernoulli trials, asymptotic theorems, Poisson theorem and random points. In the part dealing with random variables, distribution and density functions, conditional distributions and total probability are explained, as well as functions of random variables: mean and variance, moments, characteristic functions, bivariate distributions, mean square estimation. The course also introduces stochastic

convergence and limit theorems, random numbers, as well as parameter estimation and hypothesis testing.

EEE632. Stochastic signals and systems II
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course continues with stochastic processes, introducing systems with stochastic inputs, the power spectrum, digital processes. Through basic applications such as random walk, Brownian motion, thermal noise, Poisson points and shot noise, modulation, cyclostationary processes, bandlimited processes and sampling theory, bispectra and system identification it helps the student in applying the theory in practice. Introduction to spectral representation: Factorization and innovations, finite-order systems and state variables, Fourier series and Karhunen-Loéve expansions, spectral representation of random processes helps with understanding the spectra of random signals, needed for spectral estimation, namely ergodicity, extrapolation and system identification. In terms of interpolation, Mean Square Estimation and Kalman filters are employed. The maximum entropy method, coding and channel capacity, Shot noise and Markov Processes represent some other examples introduced within the course.

EEE633. Estimation and detection theory
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Through binary and maximum likelihood decisions. Neyman Pearson detectors. probability of error and min-max criteria, students see the general concept of estimation, detection and decision making. Following that introduction, course advances with binary decisions with multiple observations, sequential decision theory, giving a glimpse of composite and non-parametric decision theory. Students get a chance to learn about maximum likelihood estimators, Bayes estimators, minimum mean-squared error estimators from the viewpoint of estimation theory, complementing their knowledge from general machine learning.

EEE634. Multiresolution signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Through a revision of fundamentals of signal decompositions, time-frequency representations and filter banks are introduced, followed by wavelets. Based on the known decompositions, an analysis of efficient algorithms is performed. Being important applications, signal compression and subband coding are thoroughly analyzed.

EEE641. Special topics in communication systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course serves as a survey of new literature. Content may vary depending on student and instructor interest.

EEE642. Special topics in wireless communication systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course will give an overview of the recent advances in evolution of the wireless communication systems. Technologies behind the future wireless communication systems will be addressed covering both theoretical and practical aspects. Topics in this course will include the design issues behind the next generation of mobile communications including the

advanced techniques on the PHY layer. In addition, attractive concepts such cognitive radio will be introduced as a possible solution to improve the spectrum efficiency. Energy efficiency of the wireless networks will be properly addressed while some details regarding the resource allocation will be studied as well. Finally, two exciting topics for the industrial applications, that is wireless sensor networks and machine-to-machine communication, will be presented.

EEE661. Protective relaying
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course starts with basic relaying philosophy, and introduction to current and potential transformers. Operating principles of electromagnetic, electronic, and digital relays are explained before proceeding to application of relays to protect generators, busses, transformers and transmission lines.

EEE662. Surge phenomena
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

First topic covered in the course is the analysis and computation of electrical transients in lumpy and distributed power circuits, describing switching surges, lightning surges, traveling waves. Results of these phenomena, in terms of impact of surges on terminal equipment are analyzed as well. The engineering problem-solving in terms of insulation coordination; system protection; design of electric power apparatus and systems to operate reliably and economically in a transient environment are the focus of the second part of the course.

EEE663. Power system stability and dynamics
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

A review of power system transient and dynamic stability is covered in the course before proceeding to stability analysis with classical model and synchronous machine modeling using Park's equations. Advanced topics covered include multimachine transient stability analysis, automatic voltage regulators, speed governers and stabilizers.

EEE664. Wave propagation in power systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After a brief review of wave equations, course starts with modelling of aerial lines and cables. Based on this model, modal analysis of transmission lines is done, followed by a review of power line carrier communications. Topics like mode coupling, Solution of transmission line transients using lattice, Fourier transform and time domain methods serve as a bridge between this course and other related courses.

EEE665. Special topics in electrical machines
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course exposes the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of basic electrical machines.

EEE666. Special topics in power engineering analysis
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course exposes the students to the construction, principle of operation and performance of special topics on power system analysis as an extension to the study of basic power system.

EEE667. Special topics in power system protection
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The teaching in this course aims at establishing a good fundamental understanding of the areas covered by using formal lectures, tutorials which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material. Self-assessment questions and assignments will help student to assess themselves and find out whether they have reached the appropriate level. Mini-projects will enable students to study a chosen specialized topic in depth. The software based experiment supports the formal lecture material and also provide the student with appreciation of current technology.

EEE670. Stochastic control systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After a brief introduction to random process in control systems, this course proceeds with stochastic control models and development of control laws by dynamic programming. In terms of systematic analysis, attention is drawn to separation of estimation and control, namely through kalman filtering, self-tuning regulators, dual controllers and the general concept of decentralized control.

EEE671. Linear systems theory
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

As an inherently mathematical course, this course starts by introducing mathematical notation and review of mathematical descriptions of dynamic systems, continuing with solution to state space equations. This part is followed by transition matrix properties, before continuing to questions of internal stability and Lyapunov stability criteria. Controllability and observability, realizability and minimal realization are covered as standard topics, as well as input-output stability, linear feedback and state observation.

EEE672. Chaotic dynamics
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Nonlinear dynamics is introduced through a review of linear and nonlinear vibration theory, followed by topics like maps, flow and the local geometric theory of dynamics, point attractors; multiple and nested cyclic attractors; strange attractors. These topics are followed by the general concept of Identification of chaotic oscillations: Poincare maps, nonlinear resonance and competing attractors. Course also covers topics from nonlinear analysis such as Basins of attractions, fractals like Julia Sets and the general notion of Fourier Spectrum, stability and bifurcation of attractors, Horseshoe maps. Measuring chaos (Lyapunov exponents) is an important topics, together with fractal set theory, information loss and entropy, as well as fractal dimensions and entropies of strange attractors.

EEE673. Nonlinear systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The course starts with eview of second-order systems, their fundamental properties and Lyapunov stability, as well as Input-output stability and passivity. The wide topic of frequency-domain analysis of feedback systems is covered, together with advanced stability analysis and Stability of perturbed systems with methods from perturbation theory and averaging, singular perturbations. Feedback control and linearization, as well as nonlinear design tools are also a part of this course's outline.

EEE675. Nonlinear control systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After a brief introduction of basic analysis tools and design techniques, this course continues with analysis of feedback systems, reaching into advanced analysis of nonlinear feedback control.

EEE676. Advanced discrete control systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After a review of discrete-time systems and the z-transform and sampling and reconstruction, the course proceeds with general open loop and closed loop discrete-time systems and their time-response characteristics. After this part, stability analysis techniques and igital controller design by pole-assignment design and state estimation are covered, before finishing with linear quadratic optimal control.

EEE677. Multivariable control systems I
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course opens with a state space characterization of linear multivariable systems. And review of concepts of controllability, observability and stability. Structural equivalence, Luenberger canonical forms and state feedback and pole placement serve as an introduction to design of observers. From the conceptual point of view, the course introduces dynamic output feedback and strong observability.

EEE678. Multivariable control systems II
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course continues with system models; system matrices; decoupling zeros; standard forms of system matrices. The classical concepts of stability and design of multivariable control systems using frequency domain methods, namely Inverse Nyquist array and characteristic loci design techniques, and their applications to industrial plants are covered.

EEE679. H-optimal control systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

H-control concept and its relation to model matching, tracking, disturbance rejection and disturbance attenuation problems is introduced at the start, followed by mathematical elements of stability theory: functional spaces, operator theory and linear matrix inequalities. The examination of the state techniques from a geometric point of view, and model order reduction using a geometric approach follow, as well as finding all stabilizing controllers. Finally, H-optimal control and synthesis through analysis and control of uncertain systems is presented.

CEN621. Cryptography and network security

Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Course opens with fundamental concepts of cryptography, block ciphers, stream ciphers, cryptographic hash functions, differential and linear cryptanalysis. The today's standard public key encryption, digital signatures, key distribution protocols, key management, authentication systems take the largest portion of the course, followed by the practical questions of security protocol pitfalls, strong password protocols, Kerberos, Internet cryptography, IPsec, SSL/TLS, e-mail security, firewalls.

CEN622. Information security
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The technical content of the course gives a broad overview of essential concepts and methods for providing and evaluating security in information processing systems (operating systems and applications, networks, protocols, and so on). In addition to its technical content, the course touches on the importance of management and administration, the place information security holds in overall business risk, social issues such as individual privacy, and the role of public policy.

CEN617. Chip multiprocessors
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This advent of large-scale multi-core processors, also known as Chip Multiprocessors (CMPs), will change the way high-performance applications are designed, implemented, and executed. CMPs have advantages over complex uni-processor systems in terms of ease of validation, power efficiency, and exploiting thread level parallelism. They will not only be the central components of future desktop machines, but they will soon be building blocks for constructing large scale parallel and distributed, computer architectures. Recent chip multiprocessors such as IBM's Cell and Sun's Niagara are an important step in this direction.

CEN645. Robot motion control and planning
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Basic concepts of motion planning are introduced at the start, together with representations of state and movement, potential functions, roadmaps. This introduction is followed by basic cell decompositions, robot dynamics and simple control. Concepts of constrained motion, hybrid planning and control are explained in detail, as well as logical reasoning methods for planning.

CEN652. Business intelligence
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The overall aim of this course is to introduce students to the basic concepts and techniques of business intelligence/ business analytics. Topics covered include business decision-making, evidence-based management, data warehouse design and implementation, data sourcing and quality, on-line analytical processing (OLAP), dashboards and data mining classification, regression and time series, case studies of business analytics practice.

CEN657. Application of computer graphics
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course revises the use of computer graphics in various engineering fields before proceeding to three dimensional modeling and representation. Color, shading and lighting methods are covered in depth, as well as representation of surfaces. Graphical databases, graphics standards as practical questions are discussed, together with conceptual issues of hidden surface problem, motion and animation, or texture mapping and controlled deformations. Previous knowledge of computer graphics is required.

CEN659. Computational intelligence
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

With the advance of increasingly faster computing hardware and cheaper memory chips, computational intelligence, also known as a part of “soft computation”, a relatively new area of research, is becoming more and more important in many engineering and non-engineering disciplines including control engineering. In this information-rich world, the plant to be controlled is becoming more and more complex and control objective is given in a more and more “high-level” fashion – not just the “zero steady state error”, “smaller overshoot” or the like requirements. The performance is usually multiobjective. There is another concern about the prior knowledge about the plant and about how to better control the complicated system. In practice, we know that, usually, there do exist some rules or site knowledge from the site-operators about the system and the control. However, these rules, usually linguistic, may contain certain fuzziness. Therefore, new computational tools are needed to effectively design the controller to achieve the multi-objective performance indices with significant uncertainties, nonlinearities, and fuzziness in the description of the model of the plant to be controlled. Computational Intelligence is a collection of the possible computational tools to solve the above problems in control engineering. This course will equip the student with the essential knowledge and useful resources to solve some of the systems control problems not easily solved using previously learned conventional control methods.

CEN661. Special topics in decision support systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This subject considers research process and different approaches used in studying decision support systems. It aims to equip research students with the skills to guide them through the key steps in developing their DSS research strategies and research proposals.

CEN664. Philosophical foundations of artificial intelligence
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces elementary terms such as action and agency; behaviorism; belief; computational models of mind; concepts; consciousness; content; context in the very beginning, before starting with theories of Davidson and anomalous monism; Dreyfus's criticisms. Issues of folk psychology and functionalism followed by Goedel's theorem; intentionality; the Language of Thought and mental representation represent an important part of the discussion within the course. More general concepts such as naturalism; perception; possible worlds; practical reasoning; propositional attitudes; rationality; reasons and causes are introduced and used throughout the course. Questions of Searle and Chinese Room; the self; thought and language; Turing Test; Weak AI vs. Strong AI makes the course practical to an extent. Previous knowledge of artificial intelligence is required.

CEN665. Data communications and computer networks

Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces the basics of data communication and networking. Students will develop an understanding of the general principles of networking as implemented in networks connected to the Internet. Specific attention will be given to the principles of network architecture and layering, multiplexing, network addressing, routing and routing protocols. Activities include setting up a local area network, the Internet, security, network management and network performance analysis.

CEN666. IT Strategy
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The technical content of the course gives a broad overview of essential concepts and methods for providing and evaluating security in information processing systems (operating systems and applications, networks, protocols, and so on). In addition to its technical content, the course touches on the importance of management and administration, the place information security holds in overall business risk, social issues such as individual privacy, and the role of public policy.

CEN667. IT governance
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The main objective of this course is to present IT governance which has task to disseminate authority to the various layers in the organizational structures within specific business, while ensuring appropriate and prudent use of that authority. This doesn't refer simply to hierarchical structures; experience has taught us that network structures allow for specialization, teaming, and building infrastructure to support those teams. Specialization allows the sum of the parts of the organization to be greater than the whole. Governance in any form is about leadership. And IT governance is about the way in which leadership accomplishes the delivery of mission-critical business capability using Information Technology strategy, goals, and objectives. IT governance is concerned with the strategic alignment between the goals and objectives of the business and the utilization of its IT resources to effectively achieve the desired results. In the course will be presented various methodologies and standards which will help to govern IT using best practices and standards.

CEN668. Network management
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Course starts with a review of the principle of Network Management Architectures & Applications before introducing simple network management protocols. A lot of attention is put on the network management functions – security, accounting & performance. Topics such as Remote Network Monitoring RMON and general management tools, systems and applications are covered in depth as well.

CEN669. Special topics in machine learning
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Main topics of this course are Machine learning techniques and statistical pattern recognition, supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality

reduction, kernel methods). From the theoretical side, the course introduces learning theory (bias/variance tradeoffs; VC theory; large margins) together with reinforcement learning and adaptive control. An important part of the course is given to applications areas (robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing).

CEN670. Special topics in data mining
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After a brief overview of Data Mining Classification, a lot of attention is given to regression, time series, as well as measuring predictive performance. Topics of practical interest such as data preparation, data reduction are introduced with practical examples. Similar approach is taken for mathematical solutions, statistical methods, distance solutions, decision trees, decision rules which are illustrated by real examples.

CEN671. Special topics in pattern recognition
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This class deals with the fundamentals of characterizing and recognizing patterns and features of interest in digital data. We discuss the basic tools and theory for understanding problems with applications to pattern recognition. We also cover decision theory, statistical classification, maximum likelihood and Bayesian estimation, nonparametric methods, unsupervised learning and clustering. Additional topics on new pattern recognition algorithms and techniques from active research are also talked about in the class.

CEN673. Selected topics in bioinformatics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The course is designed to introduce the advanced concepts, methods, and tools used in Bioinformatics. Topics include (but not limited to) bioinformatics databases, sequence and structure alignment, protein structure prediction, protein folding, protein-protein interaction, Monte Carlo simulation, and molecular dynamics. Emphasis will be put on the understanding and utilization of these concepts and algorithms.

CEN675. Industrial networks
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The course provides basic knowledge of industrial networks in computer engineering, such as WorldFIP, PROFIBUS, P-NET, LON, Foundation Fieldbus, CAN. These networks are both relevant to new technical applications and for understanding industrial network systems.

CEN682. Special topics in computer networks
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course introduces the new technologies and trends in computer networking. Students will develop an understanding of the new trends of computer networking as implemented in networks connected to the Internet. Specific attention will be given to the advanced network architecture and layering, multiplexing, network addressing, routing and routing protocols. Activities include setting up a high speed local area network, the Internet, security, network management and network performance analysis.

CEN691. Fuzzy systems and control

Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After a brief introduction on fuzzy sets and basic operations on fuzzy sets, general linguistic variables and fuzzy if-then rules, as well as fuzzy rule base and fuzzy inference engine, detailed analysis of fuzzifiers and defuzzifiers is given. Central part of the course is dedicated to design of fuzzy systems from input-output data, with attention put on both nonadaptive fuzzy control and adaptive fuzzy control.

MAN607. Advanced research methods
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Students in this course will study and evaluate research methods and problems in the major fields of psychology. Topics include experimental and quasi-experimental research designs, reliability and validity, power and meta-analyses, and ethical issues in psychological research.

MAN608. Advanced statistics
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This applied course is designed for graduate students with a prior background in statistics. This means that students should have considerable experience with multiple regression and an ability to conduct such analyses using some statistical software. The major topics of the course will include hierarchical linear modeling and structural equation modeling.

MAN629. Qualitative research methods
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

By the end of this course, you should be able to conceptualize a research problem and develop a number of complementary design, measurement, and data collection approaches to bring evidence to bear on the the problem. You should be able to prepare a research proposal, and critically evaluate the quality of evidence in published social research.

MAN663. Quantitative research methods
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

The course introduces to elemental methods of data description and inferential statistical analyses. The basic organization of the course is: (1) a general introduction to research methodology, (2) descriptive statistics, their use and interpretation, (3) the essential elements of probability, (4) the foundations of statistical inference, (5) and finally an overview of selected hypothesis tests.