COURSE DESCRIPTIONS

EEE DEPARTMENT SECOND CYCLE COURSE DESCRIPTIONS

(2014)

First year

Elective courses

EEE501. Biomedical signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces two fundamental concepts of signal processing: linear systems and stochastic processes. Various estimation, detection and filtering methods are developed and demonstrated on biomedical signals. The methods include harmonic analysis, auto-regressive model, Wiener and Matched filters, linear discriminants, and independent components. All methods will be developed to answer concrete question on specific data sets in modalities such as ECG, EEG, MEG, Ultrasound.

EEE502. Biomedical image processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces different diagnostic imaging modalities (Radiography, Ultrasound, Magnetic resonance imaging etc.) and describes role of photonics in biomedical engineering, concepts imaging, sensory response and their assessment in clinical medicine.

EEE503. Advanced biomedical instrumentation
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Course gives an advanced understanding of biomedical instrumentation. It follows the entire process of control: from sensor signal acquirement to the process control itself.

EEE504. Advanced topics in biomedical engineering
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Course covers advanced concepts needed for reliable practical application of biomedical engineering, ranging from instrumentation issues to dangers of biomedical data acquisition. While these topics might have been mentioned within other courses, here they are given in full detail.

EEE511. Optoelectronic devices
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After introduction of principle of semiconductor lasers, the course turns to modulation dynamics and single frequency lasers. Fundamental AM and FM noise properties and linewidth are discussed. Tunable semiconductor lasers. Quantum well lasers, Electrooptic modulators and switches, Detectors as parts of the system, together with integrated optoelectronic circuits, optical amplifiers-semiconductor and Erbium fiber are introduced.

Advanced concepts such as low coherence sources-superluminescent diodes and tunable optical filters are also discussed.

EEE512. Semiconductor device manufacturing
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course deals with Integrated circuit device fabrication and surface micromachining technology. Processes of thermal oxidation, ion implantation, impurity diffusion, film deposition, expitaxy, lithography, etching, contacts and interconnections, and process integration issues are thoroughly investigated. Device design and mask layout, relation between physical structure and electrical/mechanical performance are investigated on illustrative examples. MOS transistors and poly-Si surface microstructures will be fabricated in the laboratory and evaluated.

EEE514. VLSI physical design
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After giving the basic physical design requirements for VLSI this course turns to performance-oriented formulation and optimization of chip partitioning, module placement and interconnection. An important topic is optimized design and layout of on-chip modules with circuit extraction. Question of high-speed VLSI circuits is discussed, as well as yield and reliability analysis and advanced VLSI packaging and parametric testing.

EEE516. Nanoscale fabrication
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course discusses various top-down and bottom-up approaches to synthesizing and processing nanostructured materials. The topics include fundamentals of self assembly, nano-imprint lithography, electron beam lithography, nanowire and nanotube synthesis, quantum dot synthesis (strain patterned and colloidal), postsynthesis modification (oxidation, doping, diffusion, surface interactions, and etching techniques). In addition, techniques to bridging length scales such as heterogeneous integration will be discussed.

EEE517. Low power electronic circuits
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Topics this course deals with include modeling and sources of power consumption, power estimation at different design levels (circuit, transistor, and gate). Question of power optimization for combinational and sequential circuits, as well as RT and algorithmic levels is important and thoroughly answered. High level synthesis for low power, circuit and layout level design for low power, low power design flow and libraries are illustrated through examples, together with voltage scaling approaches, low power RAM, power analysis and design at system level.

EEE518. VLSI testing and reliability engineering

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

VLSI testing and design-for-test techniques are covered. The course also emphasizes reliability predictions and characterizations for integrated circuits and systems. Topics covered include: Fault Models, Test Pattern Generation, Design-for-Testability, Built-in Self-Test (BIST), System-on-a-Chip (SOC) Testing.

EEE519. Mixed analog/digital IC design
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Fundamentals of analog IC design and CAD layout, beginning with basic amplifier building blocks and continuing through fully differential operational amplifier design and compensation are given. Core building blocks for mixed-signal designs, including comparators, switched capacitor circuits, and data converters are covered as well, together with addresses system level design methodologies and integration of analog and digital circuitry in simulation and layout.

EEE520. Microwave electronic circuits
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course introduces techniques of analog circuit technology in the gigahertz high-frequency regime, transmission lines and distributed circuit elements; S-parameter design of high-frequency active circuits; computer-aided analysis and design. Emphasis is on design of planar high-frequency integrated circuits employing CMOS and SiGe technology. Circuit building blocks for broadband wired and wireless communication will be emphasized including oscillators, low-noise amplifiers, and power amplifiers.

EEE521. Electromagnetic waves and application
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Introduction to basic concepts and applications of electromagnetics waves, including plane-wave propagation, oblique incidence, energy flow and Poynting vector. Detailed explanation of geometrical and physical optics, parallel plate waveguides, coaxial waveguides, rectangular waveguides, dielectric waveguides and fiber optics is given. Other practical topics include cavity resonators, dipole antennas, aperture antennas, antenna arrays, wireless and radar applications.

EEE522. Advanced electromagnetics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Standard topics from electromagnetic such as Maxwell's equations, reciprocity theorem, integral equations are revised. Attention is given to Green's function, singularity analysis of Green's function, scattering of electromagnetic waves. Mathematical questions from integral representations and inverse problems, together with contrast function are thoroughly analyzed.

EEE523. Antenna theory
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After a review of Maxwell's equations, electric and magnetic field, concepts such as radiation pattern, directivity, gain are introduced. Technical antenna topics: matching techniques, wire antennas, array antennas, aperture antennas, Huygens's principles are discussed in depth, together with microstrip antennas, reflector, antenna design, smart antenna systems.

EEE524. Computational electromagnetics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Review of numerical solution of matrix equations and matrix eigenvalue problems, method of moments, finite difference and finite element methods, variational methods, spectral domain approach. The use of above methods in the solution of various antenna and scattering problems, and in the analysis of passive microwave components.

EEE525. Statistical theory of telecommunications
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Course deals with introduction to discrete and continuous random processes in telecommunications. Basics of filtration, correlation and detection theory.

EEE526. Satellite communications and microwave system design
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The course starts with radio wave propagation and athmospheric effects, as well as introduction of satellite systems: orbital mechanics, available technologies (C, Ku, K-bands), geosynchronous orbits and LEO's (Low Earth Orbits). Microwave link design: uplink, downlink, and transponder characterization get due attention, as well as uplink and downlink amplifiers, frequency converters, modulators, demodulators. Antenna considerations, choice and types of antennas, feeder characteristics and antenna system accessories. Path planning, Fresnell ellipsoids are a topic of much interest. Principles of frequency planning, frequency bands, and frequency band planning: two-frequency (one-pair), four-frequency (two-pair), six-frequency (three-pair), and many-frequency (many-pair) plans are discussed in depth, just like principles and types of interference, interference analysis or navigation by satellite: GPS.

EEE527. Information theory
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course aims to present the basics of Information theory and systematically introduce basics of source coding, channel and line coding, as well as some elements of cryptology.

EEE528. Cognitive radio
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Learning basic principles of cognitive radio and detailed research in the area of radio communication. New generation of radio systems aimed at satisfying the needs for high bandwidth wireless access. Throughout the course, students see the ways of better access and more efficient spectrum use.

EEE529. Introduction to stochastic systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Course covers topics related to elementary principles of modeling and analysis of stochastic processes, parameter and state estimation theory, as well as basics of stochastic systems control.

EEE530. Statistical signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After a review of probability theory and random variables: transformation (function) of random variables; conditional expectation; sequences of random variables: convergence of sequence course proceeds with stochastic processes: wide sense stationary processes, orthogonal increment processes, Wiener process, and the Poisson process, KL expansion. Ergodicity, mean square continuity, mean square derivative and mean square integral of stochastic processes are key terms covered at this point. Stochastic systems analysis in terms of response of linear dynamic systems (e.g. state space or ARMA systems) to stochastic inputs; Lyapunov equations; correlational function; power spectral density function; introduction to linear least square estimation, Wiener and Kalman filtering all have its place in the syllabus. Advanced topics such as linear models and spectrum estimation are discussed. Applications of stochastic processes are studied and reviewed through student seminars.

EEE531. High frequency filter design
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Starting with synthesis of lumped element filters, this course proceeds with lumped element filter design using prototypes and circuit transformation for realization of lumped element filters. Synthesis of distributed element filters is done through illustrative examples, as well as distributed element filter design using prototypes. Circuit transformation for realization of distributed element filters is also covered.

EEE532. Telecommunication network design
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Course introduces the customer need analysis processes in terms of telecommunication network design. It develops students' analytic abilities to deconstruct the customer needs and relating them to the contemporary technologies' abilities. Also, the student is introduced to the laws in this area.

EEE533. Internet architecture
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course covers a wide area, from the historical development of internet architecture from the beginning to the contemporary state to protocols for traffic routing online. Modes of functioning of the basic internet services are explained as well.

EEE534. Telecommunication network protocols

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

This course deals with understanding the reference models, protocol mechanisms, specification, verification, implementation and testing principles for telecommunication networks.

EEE538. Advanced digital signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course opens with algorithms for Convolution and DFT linear prediction, together with optimum linear filters and least-squares methods for systems modeling and filter design. The advanced topics such as adaptive filters, recursive least-squares algorithms for array signal processing, or QRD-based fast adaptive filter algorithms are covered as well. Essential topics such as power spectrum estimation and signal analysis with higher-order spectra are extensively explained and used.

EEE539. Speech signal processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course begins with speech generation; information contained in the speech signal; and introducing LabVIEW as an analysis tool. Typical topics are covered, including speech models. feature concept: formants, pitch. Materials from statistics and pattern recognition, as well as signal processing such as sampling theorem, discrete-time signals and z-transform, discrete-time Fourier transform, cepstrum of speech signal are used for standard speech methods like linear predictive coefficient (LPC) analysis, speech coding, speech and speaker recognition. LabVIEW, Matlab and C language will be used as demonstration and/or work tool. Students will be required to make one classroom presentation and to submit a term project.

EEE540. Mobile and wireless communications
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course will cover the main topics in mobile and wireless communications. Technical aspects and technologies behind the current wireless standards will be analyzed in detail. We start of from the channel coding where we emphasize the importance of this issue in the current mobile communications. Then, we study different multiple access techniques following the development through generations of mobile communications. A special attention will be devoted to the MIMO systems and their practical implementation. In the end, we introduce ad-hoc networks due to their importance and diverse applications in wireless communications.

EEE541. Advanced communication systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces characterization of communication signals and systems. Optimum receivers for the additive white gaussian noise channel are designed and the concept of carrier and symbol synchronization is explained, together with channel capacity and coding. Block and convolutional channel codes, signal design for band-limited channels, communication through band-limited linear filter channels are some of the topics covered. Adaptive equalization. multichannel and multicarrier systems are explained through examples, as well as spread spectrum signals for data communications or digital communication through fading multipath channels and multiuser communications.

EEE560. Stability theory of dynamical systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course makes a review of dynamical system models and classification of equilibrium solutions before delivering the results on 2-dimensional systems: Poincare-Bendixon theory for limit cycles and Liapunov theory; definitions of stability and applications to linear and nonlinear feedback systems. Key concepts addressed are input/output stability; definitions and derivation of frequency response criteria for stability.

EEE561. Design of electrical machines
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

First machine introduced in this course is induction machine: Classification, design principles, electric and magnetic loading, determination of dimensions, selection of slot numbers, reduction of parasitic torques, windings, calculation of parameters. In the second part of the course, synchronous machine design is covered: determination of dimensions and winding details, determination of characteristic curves and terminal voltage. Finally, optimum design of induction and synchronous machines and transformer design is done.

EEE562. Mechanical aspects of electric power apparatus
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

General theory of kinematics and dynamics of machines and structures with emphasis on power generating and distributing equipment. Special topics include basic concepts of vibration phenomena in mechanical systems, dynamic behavior of turbine-generator sets, self-excited vibrations in mechanical systems, earthquakes, circuit breaker linkages, short circuit forces on windings and bus structures.

EEE563. Electric and magnetic fields in electric power engineering
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Review of electromagnetic theory required to undertake analysis and design of power equipment is made, followed by experimental, analog, and digital field estimation techniques. Case studies in electric and magnetic fields such as cable and bushing design, problems of gas bus systems, electrostatic precipitation, magnetic flux penetration, eddy currents, losses, shielding, generation of torque.

EEE564. Power engineering analysis
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Course starts with a review of characteristics and equivalent circuits for transmission lines and transformers and the per unit system. Balanced threephase systems and power transfer limits, symmetrical components and sequence network characteristics of transmission lines and transformers, together with symmetrical component fault analysis and Clarke components form the topics covered.

EEE565. Advanced power system protection
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course covers investigation of current and voltage waveforms during faults and other conditions. From the practical side, it introduces distance and carrier-aided distance protection, new protection schemes applicable to high-speed protection, as well as digital relaying and recent developments in integrated protection, control and measurement systems.

EEE566. Energy efficient illumination systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After revising the classical light theories and eye, sensitivity and vision types, light reflection, absorption and transmission phenomena, this course proceeds with illumination topics such as lighting methods. Internal lighting systems and calculations, lighting apparatus and armatures, photometric measurements. Classical engineering problems of pre-project preparation fundamentals, interior electrical installations, low current and high current systems and drawings are discussed together with feeder, column and main-column line formation, Fundamentals of practical application project preparations. Practical methods such as those for low power-factor correction in internal installations, voltage-drop calculation for lighting systems are presented. Hardware Equipment for Computer Aided Design, representation of CAD Packet Program (AutoCAD) and usage of primary drawing commands in 2-Dimentional Drawing are highly practical, as well as text operations and project applications.

EEE569. Advanced high voltage techniques
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After introduction of insulation principles in HV equipment, lightning discharges and overvoltages generated in HV systems details about corona discharges and corona loss calculations are provided. General topics such as electromagnetics interference generated by HV systems and pollution flashover problem of HV insulators are discussed together with overvoltage limiting devices, high voltage insulators, bushings and circuit breakers. Insulation design of high voltage transformers, cables and capacitors is practically shown, as well as testing of HV equipment.

EEE570. Computer methods in electric power engineering
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Applies the student's knowledge of power engineering to the solution of large problems by computer methods. Treats matrix techniques, load-flow analysis, network building, short circuit studies, numerical integration, and finite element analysis as it applies to power systems and power apparatus.

EEE572. Insulation coordination
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Besides lightning, switching and temporary overvoltage, this course also deals with disruptive discharges and withstand voltages. Lightning performance of transmission lines is analyzed, as well as switching surge design and insulation coordination of HV substations.

EEE574. Advanced topics in microcontrollers
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After an overview of hardware architecture of PIC micro controllers and their assembly language, this course starts with detailed explanation of topics such as interrupts, interrupt timing and program size considerations, I/O operations, I/O port expansion, serial and parallel communication, timers, PWM, interfacing with keypad and LCD, Analog-to-Digital Converter, interfacing with sensors, 12C Bus for peripheral Chip Access, UART.

EEE575. Industrial automation systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces the classical structure of the automation systems and explains concepts of control of large-scale industrial systems: Hierarchical control, multilayer control and its optimization, as well as illustrating dedicated computer structures for process control.

EEE577. Adaptive control
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Besides introduction of real-time parameter estimation and deterministic self-tuning regulators, this course introduces early stochastic and predictive self-tuning regulators, together with modern model-reference adaptive systems. Properties of adaptive systems. stochastic adaptive control, as well as topics like auto-tuning and gain scheduling are in focus during the course. Robust and self-oscillating systems are discussed in terms of practical issues and implementation. Commercial products and applications and perspectives on adaptive control are demonstrated in a practical manner.

EEE579. Optimal control
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

Through analysis of control systems, namely multivariable linear systems and vector random processes this course introduces optimal control. Concepts of performance. Robustness lead to H2 control, the linear quadratic regulator, the Kalman filter and linear quadratic Gaussian control. On the other hand, full information control and estimation is introduced as well, together with output feedback and controller order reduction.

EEE580. System Identification
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After introducing systems and models: time-invariant linear systems in terms of simulation, prediction, and control, this course presents models of linear time-invariant systems, as well as time-varying and nonlinear systems. Methods used are nonparametric time- and frequency-domain methods, parameter estimation methods, and their convergence and consistency, asymptotic distribution of parameter estimates and computation of the estimate are considered. Recursive estimation methods are discussed, together with user's choices: options and objectives, affecting the bias distribution of transfer-function estimates. Experiment design is practically demonstrated: choice of identification criterion, model structure selection and model validation. System identification is illustratively shown in practice.

EEE581. Advanced robotics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

After fundamentals of kinematics, differential motions and velocities, this course introduces dynamic analysis and forces for trajectory planning. In terms of devices, it deals with actuators, sensors and from the algorithmic and software point of view it demonstrates image processing and analysis with vision systems and fuzzy logic control.

EEE584. Robust control systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course starts with loop shaping, weighted, and mixed sensitivity. Robustness in MIMO systems is introduced, with the system representation with the concept of generalized plant. Limitations on performance of SISO, and MIMO systems are discussed, as well as uncertainty and robustness in SISO systems. Structured uncertainties and the structured singular value, together with controller design using the DK iteration method are a part of the course explained in a detailed fashion.

EEE587. Fault tolerant control systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Analysis of control systems that can sustain component failures and continue to function is the foundation of this course, together with basic concepts of fault diagnosis and accommodation. Methods for detecting and isolating component failures, parity space and observer based approaches in fault diagnosis are introduced to enable design in this area. Evaluation of stability of control systems and techniques for recovery from failures, together with parameter insensitive disturbance attenuating redesign are covered as well.

EEE588. Variable structure control systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

After introduction to variable structure dynamic systems with sliding modes and definition of sliding mode, sliding mode in relay and variable structure systems, this course proceeds to mathematical background for variable structure control, regularization of equations and design of sliding surface and sliding mode control by Lyapunov's second method. Another important topic is sliding control in the presence of uncertainties and slide mode observers, as well as integral sliding mode.

EEE589. Embedded control systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Together with principles for design of embedded controllers, this course introduces modelling and simulation of dynamic physical systems. Methods for designing the real-time software for embedded computers are discussed, while a review of real-time systems and control engineering and basic embedded computing, sensor, and actuator technologies is given. Principles for design of embedded controllers, modelling and simulation of dynamic physical systems are introduced before methods for designing the real-time software for embedded computers. A Review of real-time systems and control engineering and basic embedded computing, sensor, and actuator technologies is made in addition to topics covered.

CEN552. Data mining
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course starts with an overview of Data Mining: classification, regression, time series. Techniques for measuring predictive performance, data preparation, data reduction are introduced, together with mathematical solutions, statistical methods, distance solutions, decision trees, decision rules.

CEN553. E-business/E-commerce
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Topics covered include electronic processing and transmission of data including text, sound and video for e-business, electronic trading of goods and services, online delivery of digital contents, electronic fund transfer, electronic bill of lading, direct consumer marketing and after-sales services. Special attention is put to e-business security, shopping carts, methods of electronic payments and XML related technologies.

CEN557. Digital image processing
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Digital Image Processing course covers the fundamentals of digital images, sampling and quantization of images, arithmetic operations, gray scale manipulations. With the use of standard algorithms it introduces distance measures, image compression techniques, connectivity, image transforms, enhancement, restoration, segmentation, representation and description.

CEN558. Computer vision
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Topics covered in this course range from image formation, image processing for feature detection, object recognition and representation to motion analysis, simple motion estimation problems, stereo vision, camera models and projections.

CEN559. Machine learning
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Machine learning techniques and statistical pattern recognition are the starting point of this course, followed by supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs; VC theory; large margins); reinforcement learning and adaptive control, applications areas (robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing)..

CEN563. Network programming
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Design and implementation of network programs, protocols and systems in this course encompass wide areas of network programming models, concurrency and concurrent programming, advanced socket programming, distributed computing, message-oriented middleware, peer-to-peer programming, mobile agents, multimedia networking, introduction to enterprise applications development.

CEN564. Distributed systems
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course covers abstractions and implementation techniques for the design of distributed systems. Topics include: server design, network programming, naming, storage systems, security, and fault tolerance. The assigned readings for the course are from current literature.

CEN565. Mobile and wireless networking
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Starting from wireless transmission (physical layer), wireless media access (link layer), telecommunication systems (such as GSM/GPRS, DECT, TETRA, UMTS and IMT-2000), wireless LANs (IEEE 802.11, Bluetooth), this course moves to mobile network layer (mobile IP, DHCP), mobile transport layer (TCP over wireless), mobile application support and finally, wireless programming.

CEN566. Mobile programming
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces different programming techniques as applied to mobile platforms. Specificareas of study will include: programming strategies for small devices – including reviewing key J2ME components such as CLDC (Connected Limited Device Configuration) and MIDP (Mobile Information Device Profile); WAP and XHTML/WML programming deployment strategies for networked mobile applications.

CEN573. Advanced bioinformatics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The course is designed to introduce the advanced concepts, methods, and tools used in Bioinformatics. Bioinformatics stands at the interface of molecular biology and information sciences and promises to provide critical tools for managing the immense volume of biological data. The bioinformatics market primarily is driven by the need of agricultural, pharmaceutical and medical biotechnological companies to increase the efficiency of their discovery and development of new crop varieties, pharmaceutical drugs and other relevant products. The pharmaceutical companies use bioinformatics to identify drug targets and drug candidates, decreasing the time to bring new therapeutics to market. Emphasis will be put on the understanding and utilization of these concepts and algorithms. The objective is to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems on their own research.

CEN574. Advanced methods in bioinformatics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The objective of this course is to train the students in software application development, mathematics, statistics, cell & molecular biology, and other bioinformatics tools like SAS (Statistical Analytical System). Emphasis would be laid on understanding scientific databases & algorithms, sequence analysis and programming in various languages applicable to modern biology. The course includes an integrated project which involves the application of the above aspects.

CEN576. Computational methods in bioinformatics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

To provide basics about the computational problems in the emerging areas Bioinformatics, Computational Biology, and Genomics to the students having varied backgrounds of engineering, computer science, and the life sciences. The course is aimed at training these students in computational to work in the area of bioinformatics and computational biology.

CEN581. Computer graphics
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

In this course, the focus is on computer graphics techniques for the generation of realistic images using techniques for defining surfaces and for calculating lighting and shading effects. Students will write programs to render 3D objects using techniques ranging from simple flat shading to complex ray-shading. User-interface design with X-windows will be introduced. We will also briefly discuss programming with the OpenGL graphics library and Java.

CEN582. Computer and network security
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course introduces techniques for achieving security in multi-user computer systems and distributed computer systems: starting from basics of cryptography, network security applications and system security, conventional encryption and message confidentiality, public-key cryptography and message authentication, authentication applications, it comes to topics such as electronic mail, IP, web, and network management security, intruders, viruses, and firewalls.

CEN583. Parallel computer architecture
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course starts with a review of Reduced Instruction Set Computer (RISC) architecture, before opening the questions of pipelined processor design (instruction and arithmetic pipelines), multiprocessor and alternative architectures, dynamic and static interconnection networks, shared memory multiprocessor systems, message passing multiprocessor systems and parallel processing.

CEN584. Embedded systems
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This is practically-orientated and advanced course in the area of electronics design and applications. It is distinctive in that it provides a strong digital technology core backed up with applications-led modules. Examples of these applications include medical and electronics, e-health, intelligent building design, automotive electronics, retail and commerce. Another feature of the course is the substantial amounts of practical work, giving students the confidence with software and digital hardware implementations using microcontrollers or general system-on-chip the methodology.

CEN585. Advanced computer networks
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course introduces the basics of computer networking. Students will develop an understanding of the general principles of computer networks. 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.

CEN591. Neural networks
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

This course explores the organization of synaptic connectivity as the basis of neural computation and learning. Perceptrons and dynamical theories of recurrent networks including amplifiers, attractors, and hybrid computation are covered. Additional topics include backpropagation and Hebbian learning, as well as models of perception, motor control, memory, and neural development.

CEN592. 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 numerical data. We discuss the basic tools and theory for signal understanding problems with applications to user modeling, affect recognition, speech recognition and understanding, computer vision, physiological analysis, and more. We also cover decision theory, statistical classification, maximum likelihood and Bayesian estimation, nonparametric methods, unsupervised learning and clustering. Additional topics on machine and human learning from active research are also talked about in the class.

CEN593. Evolutionary computing
Hours (Theoretical-Practical): 3 (3-0) ECTS: 6

The course provides basic knowledge of biologically inspired methods in computer science, such as genetic algorithms, genetic programming, and artificial life. These methods are both relevant to technical applications, for example, in optimization and design of autonomous systems, and for understanding biological systems, e.g., through simulation of evolutionary processes.

CEN594. Artificial intelligence
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

This course introduces representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view. This course also explores applications of rule chaining, heuristic search, logic, constraint propagation, constrained search, and other problem-solving paradigms. In addition, it covers applications of decision trees, neural nets, SVMs and other learning paradigms.

CEN595. Scientific research methods
Hours (Theoretical-Practical): 3 (3-0) **ECTS: 6**

Exploration of quantitative and qualitative research methods commonly used in communication studies. This is an introductory course on research methods.