

# ELECTRICAL AND COMPUTER ENGINEERING

## CURRICULUM

### Master of Applied Science

#### DEGREE REQUIREMENTS

	<b>Credits</b>
Master's Thesis	(Milestone)
EE8010 Master's Research Seminar in ELCE	
Five Elective credits	5

### Master of Engineering

#### DEGREE REQUIREMENTS

	<b>Credits</b>
Master's Project*	(Milestone)
Eight Elective credits	8

\*students may apply to substitute 2 courses for the project.

### Doctor of Philosophy

#### DEGREE REQUIREMENTS

	<b>Credits</b>
Candidacy Examination	(Milestone)
Dissertation	(Milestone)
EE9010 PhD Research Seminar in ELCE	
Four Elective credits	4

(Only one elective credit may be a Directed Studies course)

#### ELECTIVES

	<b>Credits</b>
EE8102 Signal Detection Theory	1
EE8103 Random Processes	1
EE8104 Adaptive Signal Processing	1
EE8105 Digital Signal Processing I	1
EE8107 Digital Communications	1
EE8108 Multimedia Processing & Comm	1
EE8109 Wireless Communications I	1
EE8111 Digital Signal Processing II	1
EE8112 Digital Waveform Compression	1
EE8113 Statistical Time Series Anal	1
EE8114 Optical Commun & Networks	1
EE8115 Network Engineering Anlys	1
EE8119 Wireless Communications II	1
EE8120 Applied Optimization Technique	1
EE8121 Wireless Networks	1
EE8122 Opto-electronic Devices	1
EE8201 Computer Vision	1
EE8202 Digital Image Processing I	1
EE8204 Neural Networks	1
EE8205 Embedded Computer Systems	1
EE8207 High Perform Comp Sys Design	1
EE8208 Arch Synth & Des of Dig Sys	1
EE8209 Intelligent Systems	1
EE8211 Advanced Topics in Comp Networks	1
EE8212 Digital Image Processing II	1

EE8213	Computer Network Security	1
EE8214	Computer Systems Modelling	1
EE8215	Human Computer Interaction	1
EE8216	Computer Networks	1
EE8217	Reconfigurable Computing Sys	1
EE8218	Parallel Computing	1
EE8219	Arch of Field-Prgr Gate Arrays	1
EE8301	Linear System Theory	1
EE8306	Fund Robot Dynamics & Control	1
EE8401	Computer Methods Pwr Sys Analysis	1
EE8403	Adv Topics in Power Systems	1
EE8405	Power Sys Stability & Control	1
EE8406	Electric Motor Drives	1
EE8407	Power Converter Systems	1
EE8408	Switch Mode Power Supplies	1
EE8409	Electromagnetic Theory	1
EE8410	Power Electronics	1
EE8412	Advanced AC Drive Systems	1
EE8413	Adv Digtl Contrl Of Power Elec	1
EE8414	Lightning: Modelling/Detection	1
EE8415	Distribution System Analysis	1
EE8501	VLSI System Design	1
EE8502	CMOS Analog Int Circuits	1
EE8503	VLSI Circuits & Sys for Comm	1
EE8504	VLSI Dsgn Automtn & CAD Tools	1
EE8505	Digital Systems Testing	1
EE8506	Digital CMOS VLSI Integrated Circuits	1
EE8601	Directed St: Electrical Engr	1
EE8603	Sel Topics: Computer Engr I	1
EE8604	Sel Topics: Electrical Engr I	1
EE8605	Sel Topics: Computer Sci I	1
EE8606	Sel Topics: Biomedical Engr I	1
EE8607	Sel Topics: Computer Engr II	1
EE8608	Sel Topics: Electrical Engr II	1
EE8609	Sel Topics: Computer Sci II	1
EE8610	Sel Topics: Biomedical Engr II	1

## **COURSE LISTING**

### **Master's Thesis**

The student is required to conduct advanced research on a topic chosen in consultation with the student's thesis supervisor. The supervisory committee, and the thesis supervisor, must also approve the thesis research plan/proposal, which is presented in writing by the student. The student must submit the completed research in a thesis format to an examination committee and make an oral presentation of the research thesis, and the research results, to this committee. The examination committee will assess and grade the candidate's research thesis. Through the thesis, the student is expected to furnish evidence of competence in research and a sound understanding of the specialty area associated with the research. This is a "Milestone." Pass/Fail

### **Master's Project**

The Project may consist of an advanced design assignment, laboratory research project, analysis of research data, or an in-depth review of an approved aspect of the scientific literature. The student presents the proposed project plan in writing, which must be approved by the project supervisor, and the supervisory committee. The MEng candidate must submit two copies of the completed project report to the supervisor. An oral presentation of the project report, and results, will be arranged in a seminar format. The supervisor and another member of the supervisory committee will assess and grade the candidate's project report and the presentation. This is a "Milestone." Pass/Fail

**Candidacy Examination**

This is a "Milestone." Pass/Fail

**Dissertation**

The student is required to conduct advanced research on a topic chosen in consultation with the student's supervisor. The supervisor and supervisory committee must approve the research proposal, which is presented in writing and orally by the student. The student must submit the completed research in a dissertation format and make an oral presentation to an examination committee. The examination committee will evaluate the presentation and the dissertation. Through the dissertation, the student is expected to furnish evidence of competence in research and a sound understanding of the specialty area associated with the research. The research is expected to result in original and significant contribution to knowledge in the discipline. Pre-requisite: Candidacy Examination. This is a "Milestone." Pass/Fail

**EE8010 Master's Research Seminar in Electrical and Computer Engineering**

This course consists of weekly seminars with emphasis on current research in the specialization fields and emerging areas of electrical and computer engineering. This course will run through Fall and Winter semesters, 1 hour/week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. In order to achieve a pass grade in the course, the student must attend a minimum of 75% of the seminars and do an oral presentation on a research topic. Pass/Fail.

**EE8102 Signal Detection Theory**

Classical and statistical detection theory, multiple hypotheses, composite hypotheses, sequential analysis. Classical estimation theory. Representation of random processes. Detection of signals (white and coloured noise, signals with unknown parameters). Estimation of signal parameters. Linear filtering theory, estimation of continuous waveforms. Wiener and Kalman filtering. 1 Credit

**EE8103 Random Processes**

Probability theory: mathematical model, conditional probabilities, random variables, pdf, transformation of random variables, conditional densities, statistical averages. Random processes concept; ensemble, stationarity, ergodicity, correlation and covariance, power spectral density, calculation and measurement of AVF and PSD, Gaussian random processes, noise. Transmission of random processes through linear systems: time-invariant systems, multiple terminals, Gaussian processes, non-stationary processes. 1 Credit

**EE8104 Adaptive Signal Processing**

The course begins with a brief review of linear signals and systems. Adaptive filter algorithms such as least mean squares (LMS), recursive least squares (RLS), and recursive least squares lattice (RLSL) will be covered. Linear prediction theory, autoregressive modeling, and spectral estimation will also be discussed. The course will briefly cover advanced adaptive signal analysis techniques based on time-frequency and wavelet transforms. 1 Credit

**EE8105 Digital Signal Processing I**

The class provides an introductory treatment of the theory and principles of digital signal processing, with suitable supporting work in linear system concepts and digital filter design. More specifically, the class deals with the following topics: general concepts of digital signal processing, continuous-time system analysis, Fourier analysis and sampled-data signals, discrete-time system analysis, discrete-time systems, infinite impulse response digital filter design, discrete and fast Fourier transforms, and general properties of the discrete Fourier transform. Antirequisite ELE792. 1 Credit

**EE8107 Digital Communications**

The class is intended to introduce the student to the concepts and theory of digital communications. The concepts of information, channel capacity, error probability, intersymbol interference, pulse shaping and spectrum shaping and optimum filtering are discussed. Digital multiplexing and bit stuffing, encoding, scrambling, equalization and synchronization problems are studied. Regenerative repeaters, M-ary signaling systems, basic modulation techniques - ASK, PSK and FSK; and performance characteristics of digital transmission systems are considered. 1 Credit

**EE8108 Multimedia Processing and Communications**

This course will touch some of the fundamental issues in media processing and applications. It will start with a quick look at the standards which set the baseline work for multimedia, such as MPEG-4 and MPEG-7. It will then present to the class the latest and the most important issues in multimedia, including indexing and retrieval, media coding, media transmission, human-computer interface, image and speech processing for multimedia, wireless multimedia, and more. Examples, demonstrations, and applications will also be provided. 1 Credit

**EE8109 Wireless Communications I**

This class provides an overview of wireless communications systems and fundamental analysis and design techniques. The class introduces cellular system, channel characterization for propagation losses, fading, and interference. Coding, modulation, and advanced transceiver design issues are examined. Modern mobile wireless communication system applications are reviewed. 1 Credit

**EE8111 Digital Signal Processing II**

This course covers signal processing topics such as discrete cosine transform, principal component analysis, continuous and discrete wavelet transforms, multirate filterbanks, independent component analysis, and quadratic time-frequency distributions. Applications of the above techniques in denoising, data compression, feature extraction, and source localization will also be discussed. Prerequisite: EE8105 or equivalent. 1 Credit

**EE8112 Digital Waveform Compression**

Numerical representation of waveform information; common waveform communication systems; statistical models used for waveforms; Differential PCM, motion estimation/compensation for video compressions. Transform coding: run length coding, Huffman and arithmetic coding, segmentation/ contour/edge based coding; pre-processing and post-processing strategies. Vector quantization. Sub-band coding and wavelet transform. Zero trees. Channel concerns: robustness, error recovery, masking video/image bit rate source models. Coding of two-level graphics. Review of standards: JPEG, MPEG, H.261. 1 Credit

**EE8113 Statistical Time Series Analysis**

Time-series analysis and spectrum estimation constitute an important area of digital signal processing that finds applications in sonar and radar, geophysics and oil exploration, biomedicine, speech and image processing. This course will cover the basic principles and wide variety of signal processing techniques developed for time series and spectral analysis. Topics include: definitions of power spectrum; conventional spectrum estimation methods, maximum likelihood method of Capon; maximum entropy method; parametric modeling of time series; AR and ARMA spectrum estimation; harmonic decomposition techniques; duality between spectral analysis and array processing; signal and noise subspace methods in array processing. Higher-order spectral analysis methods and applications. 1 Credit

**EE8114 Optical Communications and Networks**

The objective of the course is to provide an in-depth understanding of light wave communication systems. Active and passive state of the art photonic devices that form the backbone of high-speed optical systems will be studied. Theoretical and practical aspects of the devices as well as the optical channel will be evaluated. Relevant issues such as analog and digital optical modulation techniques, noise sources and mechanisms, optical signal processing techniques and multiple access techniques such as DWDM (dense wavelength division multiplexing) and CDMA (code division multiple access) will also be covered. Both the guided (fiber based) and free space (optical wireless) systems will be discussed. 1 Credit

**EE8115 Network Engineering and Analysis**

This course covers queuing theory, self similarity and flow control. The topics to be covered are: review of basic continuous-time and discrete-time probability distributions: exponential distribution and Poisson process, concept of Markov modeling, Markov chain and basic queueing theory, analysis of M/M/1, M/M/m, M/M/m/m, M/G/1 models, network traffic modeling: an introduction to self-similarity, fitting of different self-similar traffic models, network traffic flow control and engineering: additive-increment and multiplicative-decrement (AIMD) etc., analysis of different designs based on AIMD. 1 Credit

**EE8119 Wireless Communications II**

This is an advanced course on wireless communication. The topics to be covered include: communication over fading channels, equalization, synchronization; Spread Spectrum Systems; Co-channel Interference Control: power control, interference statistics and performance analysis, opportunistic communication over fading channels; Diversity Techniques: time, space and frequency diversity and macro diversity; Multi-antenna and Multi-carrier Systems: MIMO channels and capacity, OFDM and MC-CDMA; State-of-the-art development in digital mobile communication systems. Prerequisite EE8107/EE8109 or equivalent 1 Credit

**EE8120 Applied Optimization Techniques**

This course covers the following topics: Linear and nonlinear programming, unconstrained optimization techniques such as gradient techniques (steepest descent, conjugate gradient, Newton-Raphson) and constrained optimization techniques such as Lagrange multiplier, quadratic and dynamic programming, least square techniques, integer and mixed-integer programming. NP-complete problems: branch-and-bound as well as heuristic algorithms, graph colouring, partitioning, and maximum matching. Bounds, variable priorities, special ordered sets and search algorithms (random search, binary search, genetic algorithms, and tabu search). Optimization algorithms in Electrical and Computer Engineering areas will be discussed in depth. 1 Credit

**EE8121 Wireless Networks**

This course is a moderately advanced level course on wireless networks. This course will assume necessary background knowledge in Internet Protocol (IP) networks with particular emphasis on routing, transport protocol design (congestion control and flow control), and quality of service and then build upon it. In particular, this course focuses on four major areas of wireless networks: (1) Design of different WNs including their integration, (2) Medium access control for WN, (3) Routing in WN, and (4) TCP design for WN. A discussion on applications and security is also included to introduce the students with those topics. 1 Credit.

**EE8122 Opto-electronic Devices**

This course offers a comprehensive overview of optical properties of semiconductor devices. The course begins with the transmission properties of electromagnetic wave in different media. This introduction is followed by the devices that generate light: light-emitting diodes (LEDs) and laser diodes (LDs). Topics also include optical spectra and transitions, spontaneous and stimulated emission, population inversion, carrier and optical confinements in heterostructures, etc. Some of the most popular devices such as LCD, CCD, DVD and LED will be discussed. The last part is the semiconductor photodetectors such as photoconductors, photodiodes and avalanche photodiodes. 1 Credit.

**EE8201 Computer Vision**

This course introduces the fundamental concepts for computer and robot vision. Mainly, intermediate and high-level vision processes will be covered, including shape feature extraction, representation and aggregation. Basic concepts of surface orientation, optical flow, and texture will be introduced for 3D shape analysis. Shape from shading, contour, texture, motion and stereo techniques will also be covered. Special topics in application of computer vision including automated visual inspection; robotic vision, autonomous navigation, etc. will be presented.

1 Credit

**EE8202 Digital Image Processing I**

This course starts with the introduction to digital image fundamentals, imaging geometry, and image storage formats. Simple spatial domain techniques as well as spatial frequency domain methods and digital filter design for image enhancement and restoration are discussed. Low-level image segmentation and feature extraction concepts will also be introduced. Special topics in application of image processing including remote sensing, medical imaging, etc. will be presented. 1 Credit

**EE8204 Neural Networks**

The class deals with preliminaries of artificial neural systems including fundamental concepts and models. Single layer perception classifiers and multi-layer feed forward networks, single-layer feedback networks, and associative memories are covered. 1 Credit

**EE8205 Embedded Computer Systems**

This course focuses on the design and implementation of software for embedded systems. High performance embedded system and safety critical embedded system architecture will be introduced, Fault-tolerant and reliable embedded system design techniques are also highlighted. The main topics to be covered include embedded computer organization, hardware/software codesign of embedded systems, CAD tools for hardware/software codesign, system on chip, advance concepts of real-time operating systems and real-time scheduling. The course introduces the technologies used in the design of embedded systems such as processor cores, embedded system specification languages, and software tools for hardware/software co-verification and system partitioning. The application of embedded systems for emerging networking and medical devices will also be covered. 1 Credit

**EE8207 High Performance Computer System Design**

This course will focus on the design of high performance computer systems. Topics covered include: Advanced pipelining and parallelism issues, including branch prediction, instruction and data level parallelism; Advanced processors including superscalar, VLIW, speculative, vector and multi-processors; Physical limitations and scalability issues; Real-world examples including MMX technology, PowerPC and Alpha architectures, and DLX architectures. The lab projects include using CAD tools to design a branch predictor and trace cache for Pentium 4 processor. Antirequisites: ELE818, COE818. 1 Credit

**EE8208 Architectural Synthesis & Design of Digital Systems**

This course will explore the methodologies for high-level architectural synthesis and low-level logic design of digital systems and architecture-to-task optimization techniques. Topics will include: architecture overview of modern computing systems, overview of recent hardware basis for custom digital systems (FPGA and CPLD) and hardware description languages (VHDL), methodology for high-level architectural synthesis including resource scheduling and binding, and low-level logic synthesis of digital systems. Case studies on synthesis process of digital systems from functional and technical specification to electrical schematic diagram will be discussed. Students are expected to read selected papers from current research literature, learn one of hardware description languages (VHDL or Verilog) and perform a project using a commercial CAD system. 1 Credit

**EE8209 Intelligent Systems**

This course introduces the fundamental practice and underlying principles involved in the study of intelligent systems. The emphasis of the course is on a practical approach to problem solving and learning processes in the context of neural networks. In addition to theoretical, mathematical, and implementation of such systems students will get exposure to some of the popular intelligent systems tools. Applications in signal processing, pattern recognition and vision will be considered. Antirequisite: ELE888 1 Credit

**EE8211 Advanced Topics in Computer Networks**

Topics covered include design and operation of computer networks, Gigabit Networking, Fiber Optics and SONET standards, Cell Networking, Asynchronous Transfer Mode, Wide Area and Local Area Cell networks, Gigabit packet networks, Applications, Internetworking Protocols, Traffic Modelling and Performance Issues, Switch Architectures and current research areas. Practical aspects of network software design are also discussed. 1 Credit

**EE8212 Digital Image Processing II**

This course deals with advanced concepts in digital image processing. In particular, emphasis will be on color image processing. The concepts that will be covered include: color vision, trichromacy theory, color spaces, colour image creation/representation/storage, component colour image processing, vector colour image processing, segmentation, and colour image compression. The course will include a practical aspect by discussing applications and implementations of image processing techniques currently in use in industry. The course will have student implemented assignments and projects that will require hands-on programming, literature reviews and oral presentation. Prerequisite: EE8202 or equivalent 1 Credit

**EE8213 Computer Network Security**

This course provides a thorough understanding of technologies and methodologies in network security. It deals with the fundamental techniques used in implementing secure network communications, and forms of attacks on computer networks and approaches to their prevention and detection. Topics that are covered include Introduction to Cryptography, Virtual Private Networks (VPN), Firewalls and intrusion detection techniques. In addition, the course covers worms, viruses, and DDOS attacks and their remedies. Kerberos authentication Protocol, SSL, and anonymous communication protocols. 1 Credit

**EE8214 Computer Systems Modeling**

The objectives of this course are to study the characteristics of various analytical models of computer systems and to learn how to apply those models to analyze system performance and dependability. The modeling techniques to be covered include Poisson, renewal, Markov processes, fault trees, Petri nets and queuing networks. Examples include models of computer systems, computer networks, and wireless systems. 1 Credit

**EE8215 Human Computer Interaction**

The course is designed as an introduction to Human Computer Interaction from the perspective of human capabilities and limitations. It will provide the student with an understanding of human sensory systems and information processing models to support future work in any systems design where there is a human interface. Applications range from basic computer interfaces and web page design to semi-autonomous robotics and remote systems control to the design of complex systems such as flight simulators or other virtual environments. By the end of the course, the student will have gained knowledge in some of the essentials of cognitive human factors and information theory concepts, and an understanding of factors that affect human performance such as memory, learning, attention and reaction times. The student will be capable of specifying displays and controls to optimize overall useability and system performance outcomes. 1 Credit

**EE8216 Computer Networks**

This is an advanced course in computer networking. The course is designed to include materials relevant to the industry, for example IP QoS and TE necessary for VOIP and MPLS services. The course deals with the principles, architectures, algorithms, and protocols related to Internet, with emphasis on routing, transport protocol design, flow control and congestion control, IP Quality of Service and Traffic Engineering. It also introduces IP security. Anti-requisite: COE865 or ELE865. 1 Credit

**EE8217 Reconfigurable Computing Systems**

This course will introduce the theory and engineering design principles of the modern reconfigurable computing systems (RCS). The emphasis is on the understanding of the concepts of architecture reconfigurability, programmable logic devices and optimization of the RCS architecture to the task algorithm and data structure. It will also cover basics of the complex programmable logic devices, and FPGA organization and RCS architectures based on these devices. The survey of RCS and areas of their application will also be provided. Languages and compilers for the RCS are other aspects to be covered in this course. Course gives brief description of RCS application in DSP, video and image processing, and supercomputing. Then the specifics of RCS design will be discussed including DSP and embedded processor design flow, modular and incremental design. Synthesis, simulation and verification design tools also will be discussed in details. 1 Credit

**EE8218 Parallel Computing**

This course will introduce students to parallel computing including parallel algorithms, parallel programming and different parallel architectures. It covers the basic programming models used in parallel computers, parallel algorithms, parallel programming, the shared memory multiprocessor and NUMA multiprocessor. The Laboratory projects include parallel programming using one of the parallel models. 1 Credit

**EE8219 Arch of Field-Programmable Gate Arrays**

This course will cover the following: Modelling and Evaluation of FPGA Architectures, High-Level CAD Algorithms used in FPGA Architectural Evaluation – Synthesis, Technology Mapping and Packing Tools, Physical-Level CAD Algorithms used in FPGA Architectural Evaluation – Placement and Routing Tools, Architecture and Computer-Aided Design (CAD) Tools for Commercial FPGAs, Power Modelling and Power-Aware CAD Tools for FPGAs, Low Power FPGA Architectures and Circuit-Level Design Techniques, Dynamically Reconfigurable Architectures. 1 Credit.

**EE8301 Linear System Theory**

The main thrust of the class is to introduce an algebraic unification of finite-dimensional linear systems with emphasis on continuous and discrete dynamic systems, using an operator theoretic approach. Topics covered include transition matrices, functions of matrices, adjoint systems, weighing patterns, realizability; canonical forms; stability, minimal realization; minimum norm, and approximation problems. 1 Credit

**EE8306 Fundamentals of Robot Dynamics and Control**

This course provides a comprehensive treatment on the fundamentals of robotics, particularly in the kinematics, dynamics and control of robotic manipulators. Topics include: forward dynamics, homogeneous transformation; the Denavit-Hartenberg representation of linkages. Inverse kinematics: closed-form and numerical solutions. Differential motion; Jacobian matrix; singularities. Dynamics: the Euler-Lagrange formulation. Trajectory generation. Motion and interaction control of robotic manipulators. Actuators and sensors. Antirequisite ELE869. 1 Credit

**EE8401 Computer Methods in Power System Analysis**

Advanced topics in load flow analysis; Decoupled load flow, inclusion of high-voltage direct current links in load flow. Parameter estimation for power systems. Static state estimation. Load modeling. 1 Credit

**EE8403 Advanced Topics in Power Systems**

Basic concepts. Review of optimization techniques. Linear and non-linear programming. Pontryagin's maximum principle. Fletcher-Powell method, etc. Systems security monitoring. State estimation. Optimal power flow. Real and reactive power optimization. On-line optimization. Load dispatching. Generator scheduling, maintenance scheduling in hydro, thermal and hydrothermal systems. Some case studies.

1 Credit

**EE8405 Power System Stability and Control**

This is an advanced course in power system stability studies focused on the design of digital signal processing systems for improvement of steady state and transient power system stabilities. This course provides studies on analytical techniques and computer methods for power system stability enhancement, and digital signal processing control design and implementation of advanced power system stabilizers. 1 Credit

**EE8406 Electric Motor Drives**

Characteristics of dc and ac motors, speed-torque profiles of motors and loads, motor models, principle of motor speed control, field and armature current control for dc motor drives, V/F control and field oriented control for ac motors, motor drive dynamics, digital implementation, drive performance evaluation, industrial application examples. 1 Credit

**EE8407 Power Converter Systems**

Principle of ac to dc converters, dc/dc and dc/ac converters, voltage and current source converters, multi-level high-power converters, pulse width modulation techniques, harmonic reduction techniques, modeling and simulation techniques, and industrial applications. 1 Credit

**EE8408 Switch Mode Power Supplies**

Flyback converters, forward converters, bridge converters, Cuk converters, pre-regulators, inrush control, start-up methods, overvoltage and undervoltage protections, foldback current limiting, output filters, transformer design, induction and choke design, current mode control, stability. 1 Credit

**EE8409 Electromagnetic Theory**

The course will cover the following: Electromagnetostatic fields, Maxwell's equations, Poynting and uniqueness theorems, losses due to polarization damping forces, Helmholtz wave equation, auxiliary potential functions, reciprocity theorem. Transverse electromagnetic waves, wave polarization, reflection and transmission at interfaces, wave matrices, oblique incidence. Waves between parallel planes, rectangular and circular waveguides, microwave cavities, Antennas, antenna characteristics. 1 Credit

**EE8410 Power Electronics**

A course on microprocessor-controlled solid state converters. Major topics include: solid state switching devices, dc-dc switch mode converters, diode & thyristor rectifiers, current & voltage source inverters, industry applications and microprocessor programming techniques. Typical control schemes for these converters will also be discussed. Important concepts are illustrated with laboratory design projects. An MC68HC11 microprocessor based MPP board will be used in the projects. Antirequisite: ELE754 1 Credit

**EE8412 Advanced AC Drive Systems**

The topics include general configurations of voltage source inverter (VSI) and current source (CSI) fed drives, reference frame theory, space-vector and dq-axis models of ac machines, dynamic behavior of ac machines, principle of field orientation, indirect and direct field oriented controls for VSI and CSI drives, direct torque control, sensorless control of ac drives, observers for flux, torque and speed, and simulation and design of closed-loop control systems. 1 Credit

**EE8413 Adv Digital Control of Power Electronics**

A course on the design of digital system for power electronic applications. Major topics include are: digital implementation of switch mode power supplies, digital control of active filters, voltage compensators, reactive power compensator, PWM rectifiers, and AC motor drive systems. The course focus on the digital design of the control system including modeling, digital signal processing, digital filter design and digitalize of an analog control system. The implementation includes the DSP/FPGA control system, A/D conversion, gate signal generation and hardware design of the digital control system. 1 Credit

**EE8414 Lightning: Modelling and Detection**

This course will cover the following: Thunderstorm electrification mechanisms, electrical structure of thunderstorm clouds, the electrostatic dipole and tri-pole models. The mechanisms of the downward-initiated lightning flash and tall-structure lightning. Mathematical modelling of the lightning return stroke current, calculation of the lightning-generated electromagnetic pulse (LEMP). Measurement of the lightning current and its generated LEMP. Lightning detection systems. Deleterious effects of lightning and protective techniques. 1 Credit

**EE8415 Distribution System Analysis**

This course will cover: Review of Transmission line modeling, Transformer modeling, load modeling, system representation using Y-Bus and three phase systems, Power Balance equations and solution using Newton-Raphson's method, Voltage solution of distribution systems using Ladder Network theory and such methods, Voltage solution of distribution systems using specially constructed system of equations and their solution through Newton-Raphson's method, Maximum line loadability indicator and their relevance to renewable energy resources, Network Reconfiguration and methods. 1 Credit

**EE8501 VLSI System Design**

This course deals with the design of CMOS integrated circuits using deep sub-micron CMOS technology at the system level. The course consists of two essential components: theory and project. The theoretical component consists of : advanced topics on modeling of MOS transistors, modeling of interconnects (lumped, distributed RC, distributed RLC, and transmission line models), impedance matching techniques, layout techniques for high-speed digital and mixed analog-digital circuits, clock generation and distribution on chip, power distribution on chip, analog and digital grounding of mixed analog-digital circuits on chip, I/O and pad design, packaging and ESD protection, switching noise, and high-speed data links. The project component consists of design, layout, and simulation of CMOS circuits using state-of-the-art CMOS technology and CAD tools. Antirequisite: ELE863 1 Credit

**EE8502 CMOS Analog Integrated Circuits**

The class deals with providing a detailed description of the MOS (Metal-oxide-semiconductor) transistor in conjunction with analog MOS circuitry. Major topics that will be covered are: introduction to semiconductor physics, pn junctions, MOS capacitors, DC and AC characteristics of MOSFET, analysis of analog MOS elements (current mirrors, amplifiers, and biasing circuitry), noise and RF using MOS transistors will also be addressed. Antirequisite ELE704. 1 Credit

**EE8503 VLSI Circuits and Systems for Communications**

This advanced graduate course deals with the design of VLSI circuits and systems for communications. Major topics include fundamentals of data communications (modeling of MOS devices, noise figure, PCM, PAM, inter-symbol interference, modeling of channels, transmission lines and impedance matching, pre-emphasis and post-equalization), wideband amplifier design techniques (low-noise design, gain-boosting, bandwidth enhancement, switching noise, mismatch compensation, voltage-mode and current-mode), high-speed electrical signaling schemes, Gbps serialization and de-serialization, voltage and current-controlled oscillators, phase noise of oscillators, phase-locked loops, clock and data recovery. Prerequisites: EE8501 or EE8502 or equivalent 1 Credit

**EE8504 VLSI Design Automation and CAD Tools**

The objective of this course is to introduce the fundamental principles of VLSI (Very Large Scale Integrated) circuit design and layout. This course is targeted towards an introduction to the mathematical topics of "algorithmic graph theory", and will be followed by introductions to "computational complexity" and "general methods for Combinatorial optimization" for layout partitioning, floorplanning, placement, routing and compaction based on exact mathematical programming (linear, integer and nonlinear programming) as well as an introduction to advanced heuristic techniques (i.e. Tabu search, genetic algorithms and simulated annealing, neural networks, etc.). 1 Credit

**EE8505 Digital Systems Testing**

The course covers theory and techniques for digital systems testing and testable design. The concepts of fault modeling, fault simulation, test generation, bridging faults testing, functional testing, and logic-level diagnosis are examined. RAM testing, PLA testing, FPGA and microprocessor testing, and design for testability issues are discussed. Compression techniques, built-in self-test and self-checking circuits are considered. 1 Credit

**EE8506 Digital CMOS VLSI Integrated Circuits**

This course will provide students with various topics in the design and analysis of digital CMOS VLSI integrated circuits. Some of these topics will be discussed deeply and other moderately. The major topics to be covered are: (1) System-level and intellectual property block design methodologies, (2) MOSFET (Metal Oxide Semiconductor Field Effect Transistor) modeling and analysis, (3) Logic families such as complementary CMOS, ratioed CMOS, and dynamic CMOS, (4) Circuit characterization and performance estimation, (5) Interconnects analysis and modeling, (6) Sequential circuits design, and (7) Subsystems design and analysis. 1 Credit

**EE8601 Directed Studies in Electrical Engineering**

This class is available to graduate students in electrical engineering, who wish to gain knowledge in a specific area for which no graduate-level classes are offered. Students are assigned an advisor and are required to present a formal report, or take a formal examination, at the end of the class. 1 Credit

**EE8603 Selected Topics in Computer Engineering I**

This course consists of lectures, seminars, and readings covering the latest advances and research in Computer Engineering such as communications, signal processing, and computer hardware and software. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8604 Selected Topics in Electrical Engineering I**

This course consists of lectures, seminars, and readings covering the latest advances and research in electrical Engineering such as electronics, electromagnetics, controls and power devices. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8605 Selected Topics in Computer Science I**

This course consists of lectures, seminars, and readings covering the latest advances and research in Computer Science. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8606 Selected Topics in Biomedical Engineering I**

This course consists of lectures, seminars, and readings covering the latest advances and research in Biomedical Engineering. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8607 Selected Topics in Computer Engineering II**

This course consists of lectures, seminars, and readings covering the latest advances and research in Computer Engineering. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8608 Selected Topics in Electrical Engineering II**

This course consists of lectures, seminars, and readings covering the latest advances and research in Electrical Engineering. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8609 Selected Topics in Computer Science II**

This course consists of lectures, seminars, and readings covering the latest advances and research in Computer Science. The course description will be announced prior to scheduling of the course. 1 Credit

**EE8610 Selected Topics in Biomedical Engineering II**

This course consists of lectures, seminars, and readings covering the latest advances and research in Biomedical Engineering. The course description will be announced prior to scheduling of the course. 1 Credit

**EE9010 PhD Research Seminar in Electrical and Computer Engineering**

This course consists of weekly seminars with emphasis on current research in the specialization fields and emerging areas of electrical and computer engineering. This course will run through Fall and Winter semesters, 1 hour/week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. In order to achieve a pass grade in the course, the student must attend a minimum of 75% of the seminars and do an oral presentation on a research topic. Pass/Fail.