Courses Description

ELEE 500 Probability and Stochastic Processes (3 Credit Hours)
This course is intended as a first semester graduate course on probability and stochastic processes with application to signal processing, communications, estimation and control. The objective is to present a comprehensive coverage of the basic tools needed by an electrical engineering graduate student specializing in the above areas. ***Prerequisite: STAT 230, ELEE 350***

ELEE 501 Linear System Analysis (3 Credit Hours)
Fundamental concepts in linear system theory: matrix algebra, linear vector space, linear operator; linearity, causality, relaxedness, and time invariance. Input-output and state space models. Solutions of linear dynamic equations and impulse responses. Characteristics of linear systems: controllability, observability and stability. ***Prerequisite: ELEE 380, MATH 215***

ELEE 502 Optimization Techniques for Electrical Engineering (3 Credit Hours)
Optimization theory and algorithms and their application to electrical engineering. Sparse optimization methods, Eigen-decomposition techniques, the expectation maximization algorithms, stochastic optimization techniques, and special techniques relevant to large-scale optimization. ***Prerequisite: MATH 215***

ELEE 503 Advanced Control Systems (3 Credit Hours)
This is a first graduate level course on control systems with an emphasis on controller design. The course will deal mainly with linear systems (or linearized systems) in discrete time domain. The Z-transform will be also introduced and practiced in the analysis of open loop and closed loop discrete time systems. The design of digital control systems and its stability will be also introduced in this course. In class and homework examples will be taken from various application domains and research projects, and MATLAB will be used for analysis, design and simulations of these systems. ***Prerequisite: ELEE 380, ELEE 399L***

ELEE 504 Advanced Power System Analysis (3 Credit Hours)
A course on optimal dispatch of generation, symmetrical components and unbalanced faults, transient stability, control of generation, state estimation in power systems, and power system simulation. ***Prerequisite: ELEE 461***

ELEE 506 Advanced Analysis of Electric Machines (3 Credit Hours)
Generalized theory of electrical machines, transient analysis in transformers: short circuit forces, inrush currents, transients and dynamics of DC and AC machines (synchronous and induction), special machines: brushless AC motors, switched reluctance motors, linear motors, stepper motors, computer implementation and analysis of electrical machines. ***Prerequisite: ELEE 360, ELEE 463***

ELEE 507 Digital Communications (3 Credit Hours)
Elements of communication theory and information theory applied to digital communications systems. Characterization of noise and channel models. Characterization of communication

signals and systems, representation of digitally modulated signals and spectral characteristics. Optimum receivers for AWGN channels: evaluation of error rate performance and channel bandwidth requirements. Broadcast and Multiple access channels. FDMA, TDMA, and CDMA. ***Prerequisite: ELEE 470***

ELEE 508 Advanced Digital and Data Communications (3 Credit Hours)
Digital signaling over channels with intersymbol interference and AWGN. Wireless multipath channel models: time and frequency dispersive channels, level crossing and average fade duration. Diversity concepts: modeling and error probability performance evaluation. Spread spectrum in digital transmission over multipath fading channels, performance analysis and fading mitigation techniques. ***Prerequisite: ELEE 507***

ELEE 511 Modeling and Simulation of Communication Systems (3 Credit Hours)
The course covers the principles and methods for simulation of computer networks and data communication systems. Topics include: Simulation and modeling basics (traffic modeling, link-, system-, packet level simulation, SW/HW in the loop), probability theory fundamentals, random number generation, mobility models, channel models, topology models, graph theory and algorithms, queuing models, queuing networks, network calculus, discrete event-based simulation, Monte-Carlo simulation, rate-based simulation, analysis of simulation results, statistical analysis, visualization of results, simulation languages and tools, simulation packages. ***Prerequisite: ELEE 470, ELEE 500***

ELEE 512 Power System Planning (3 Credit Hours)
Mathematical methods and modern approaches to power system planning. Demand forecasting. Generation system planning: deterministic and probabilistic methods. Transmission system planning: heuristic and stochastic methods. Optimization methods for transmission planning. Route selection: environmental and other considerations. Distribution system planning: system layout, and choice of components. ***Prerequisite: Advisor Consent***

ELEE 513 Renewable Energy Systems (3 Credit Hours)
This course seeks to impart in students a sound understanding of renewable energy systems. The course includes: wind energy, solar energy, hydro power and geothermal energy systems. ***Prerequisite: Advisor Consent***

ELEE 514 Environmental Impacts of Energy Systems (3 Credit Hours)
World energy resources and classifications. Sources and effects of air pollution. Air quality modeling, Gaussian dispersion models. Motor vehicles emissions and noise pollution, mitigation strategies. Environmental impacts of electricity generation, pollution control systems, electromagnetic radiations. Environmental impact assessment. ***Prerequisite: Graduate standing.***

ELEE 515 Energy Policy and Planning (3 Credit Hours)
A course that focuses on features of modern energy planning and policy. Topics covered include the interaction among the technological, economic, environmental, and sociopolitical aspects of energy supply and use; electricity, oil, and gas industries, and their market structures; elements of energy planning on the sector and national levels; energy decision-making under conditions of uncertainty, risk management in energy planning; liberalization of energy markets; case studies.

Prerequisite: Graduate standing

ELEE 516 Power Electronics Systems and Applications (3 Credit Hours)
A course that reviews converter topologies for AC/DC, DC/AC, and DC/DC; power supply applications; converter applications to motor drives; utility interface of distributed energy systems; static VAR systems; flexible AC transmission; high voltage DC; power quality control; active and passive harmonics compensation. ***Prerequisite: ELEE 461, ELEE 462***

ELEE 517 Electric Power Systems Control and Stability (3 Credit Hours)
A course on short-term load forecasting, generation unit commitment, economic load dispatch, loss formula coefficients, nonlinear programming, optimal power flow, security assessment, security dispatch, spinning reserve evaluation, automatic generation control, reactive power and voltage control, and state estimation. ***Prerequisite: Graduate standing***

ELEE 518 Energy Efficiency in the Power Sector (3 Credit Hours)
Topics covered in the course include: utility companies and energy supply; energy sustainability; cogeneration systems: CHP and CCGT; reciprocating engines; distributed generation; demand side management; energy audit: types and data analysis, monitoring and targeting of energy, energy- efficient rotating machines, design and performance optimization. Case studies. ***Prerequisite: Advisor Consent***

ELEE 519 Smart Grids (3 Credit Hours)
The concept of Smart-grid, with network, components, technologies and trends. Significance to participants throughout the value chain, opportunities, threats, business models and regulatory issues. Integration of distributed variable generation, planning, management, operation, voltage stability and protection Advanced metering systems and intelligent buildings with demand side management and energy efficiency. ***Prerequisite: ELEE 461***

ELEE 520 Protection of Power Systems (3 Credit Hours)
A course on the elements of protection in power systems mainly targeting design and implementation of protective relays: operating characteristics; power and current directional relays; differential relays; distance and wire pilot relays; protection of generators, busbar, capacitors and reactors; reclosers; under frequency relays; heating and harmonic effects; and Computer-based protective device coordination; instrument transformer (effect of dc component, estimation of CT performance), coupling capacitor voltage transformer. ***Prerequisite: ELEE 469***

ELEE 521 Electric Safety and Grounding System Design (3 Credit Hours)
This course discusses grounding of power systems and equipment; the impact of grounding on system performance, system equipment integrity, safety of personnel as well as safety of the public at large. The course addresses the problem of grounding mainly in distribution systems: the effects on reliability of supply to customers, survivability of end-use equipment, and safety of individuals. ***Prerequisite: ELEE 469***

ELEE 522 Special Topics in Energy and Power Systems (3 Credit Hours)
Advanced topics selected from the broad area of energy and power systems to provide the student with knowledge of recent advances and contemporary development in this area. ***Prerequisite: Graduate Standing, Advisor Consent***

ELEE 525 Digital Control Systems (3 Credit Hours)
The course covers the design of practical control systems intended for implementation using digital controllers and embedded systems. In particular, the course covers: digital control systems, discrete systems, stability analysis, digital controller synthesis, digital PID controllers, design of digital controllers, state-space models, observability and controllability, pole placement design, optimal design methods, nonlinear discrete-time systems, digital control of power systems, case studies. ***Prerequisite: ELEE 501, ELEE 503***

ELEE 532 Information Theory (3 Credit Hours)
This course introduces the field of information theory and its applications to communications theory, computer science, statistics, and probability theory. Covering all the essential topics in information theory, we introduce the basic quantities of entropy, relative entropy, and mutual information, and show how they arise as natural answers to questions of data compression, channel capacity, rate distortion, and hypothesis testing. ***Prerequisite: Graduate standing***

ELEE 533 Queuing Theory (3 Credit Hours)
A course that covers Poisson counting and renewal processes; Markov chains and decision theory, branching processes, birth death processes, and semi-Markov processes; simple Markovian queues, networks of queues, general single and multiple server queues, bounds and approximations. ***Prerequisite: ELEE 500***

ELEE 534 Stochastic Processes, Detection, and Estimation (3 Credit Hours)
This is a graduate-level introduction to the fundamentals of detection and estimation theory involving signal and system models in which there is some inherent randomness. The concepts that we'll develop are extraordinarily rich, interesting, and powerful, and form the basis for an enormous range of algorithms used in diverse applications. The material in this course constitutes a common foundation for work in the statistical signal processing, communication, and control areas. ***Prerequisite: ELEE 500***

ELEE 535 Multimedia and Advanced Signal Processing (3 Credit Hours)
The course provides an overview of the current multimedia standards and technologies and a brief description of future technologies. It also addresses the fundamental principles and techniques in multimedia signal processing: text, graphics, speech, audio, image, video; standards for multimedia coding, processing and compression. ***Prerequisite: ELEE 350***

ELEE 536 Computer Network Architectures and Protocols (3 Credit Hours)
This course introduces the concepts and techniques used to model and implement communications between processes residing on independent hosts. The course examines the conceptual framework for specifying a computer network - the network architecture, and investigates the set of relevant protocols. The OSIRM is presented, and the service definitions

and protocol specifications for implementing each of the seven layers of the Reference Model are analyzed in detail. ***Prerequisite: ELEE 431***

ELEE 537 Wireless Networks (3 Credit Hours)
The objective of this course is to give an introduction to the fundamentals of the wireless communications systems, the wireless network architectures, protocols, and applications. Topics of study include an overview of wireless communications and mobile computing systems, signal propagation characteristics of wireless channels, wireless channel modeling, frequency reuse/cellular/microcellular concepts, spread spectrum modulation for wireless systems, multiple access techniques, and wireless networking standards (e.g., 2.5G, 3G, IEEE 802.11, IEEE 802.15, IEEE 802.16/WiMAX, LTE). ***Prerequisite: ELEE 508***

ELEE 538 Mobile Communications Networks (3 Credit Hours)
Cellular networks, ad hoc networks; access protocols; radio and network resource management; quality of service; mobility and location management; routing; mobile-IP; current wireless technologies for personal, local and satellite networks. ***Prerequisite: ELEE 434***

ELEE 539 Optical Fiber Communication (3 Credit Hours)
Dielectric slab waveguides. Classification of mode types. Parabolic two-dimensional media. Circular waveguides. Step-index and graded-index optical fibers. Effect of loss. Dispersion effects. Fabrication methods in integrated optics and optical fibers. Light sources. Light Detectors. WDM concepts and 19 components. Optical Amplifiers. Point-to-point link system considerations. Photonic devices. Applications in communication systems. ***Prerequisite: Graduate Standing***

ELEE 541 Introduction to Optical Electronics (3 Credit Hours)
Principles, devices and materials used to generate, modulate, and detect optical radiation. Review of important properties of light and semiconductors. Light-emitting diodes and lasers. Electro-optic modulation. Thermal and quantum detection. Emphasis on semiconductor-based devices and application to fiber-optical communications. ***Prerequisites: ELEE 539***

ELEE 542 Advanced Coding Theory (3 Credit Hours)
A course that addresses digital communication principles and techniques aimed at achieving improved reliability. The course examines information measures such as entropy and mutual information for discrete and waveform channels, source coding, channel capacity and coding theorem, linear block and cyclic codes, hard and soft decision decoding, spread spectrum modulation. ***Prerequisite: ELEE 470, ELEE 473***

ELEE 543 Special Topics in Communication and Network Systems (3 Credit Hours)
Advanced topics selected from the broad area of communication and network systems to provide the student with knowledge of recent advances and contemporary development in this area. ***Prerequisite: Graduate Standing, Advisor Consent***

ELEE 544 Power System Operation (3 Credit Hours)
An advanced course that mainly introduces the basic concepts related to power system operation. It depends strongly on power system analysis. This course will introduce the Electric

power generation, transmission and distribution. State estimation, Overhead power lines, Substation design, Load and energy forecasting. ***Prerequisite: ELEE 461***

ELEE 545 Advanced Power Distribution Systems (3 Credit Hours)
Electric power distribution system planning, design and operations; load characteristics and distribution transformers; design of subtranmission lines and distribution substations; primary and secondary feeder design considerations; distribution system voltage regulation, protection and reliability; distributed generation and smart grid application. ***Prerequisite: ELEE 461***

ELEE 546 Power System Reliability (3 Credit Hours)
An advanced course that mainly introduces the basic techniques used in power systems reliability calculations. It depends strongly on Statistics and Probability theory. This course will introduce the Quantitative Reliability, Probability Theory, Stochastic Processes, Frequency Balance, Power System Reliability, Generation System Reliability, Multi-area Power System Reliability, Composite power system. ***Prerequisite: STAT 230, ELEE 461***

ELEE 550 Wireless Power Transfer (3 Credit Hours)
This course provides a comprehensive overview of the emerging field of wireless power transfer (WPT). It presents a multidisciplinary treatment of WPT theory, technology, and applications. Case studies in cutting-edge fields are explored to illuminate the basic concepts and inspire thoughts in future applications. ***Prerequisite: Advisor Consent***

ELEE 551 Electromagnetic Compatibility (3 Credit Hours)
Introduction to Electromagnetic Compatibility (EMC), EMC requirements of electronic systems, signal spectra, non-ideal behavior of components, conducted emissions and susceptibility, radiated emissions and susceptibility, crosstalk, shielding, and system design for EMC. ***Prerequisite: ELEE 490***

ELEE 553 Antennas for Wireless Communications (3 Credit Hours)
The principles of analysis and design of antenna arrays are discussed. Special attention is paid to antennas popular in mobile (cellular, satellite) telecommunications: Fundamental parameters; radiation integrals; wireless systems; wire, loop, and microstrip antennas; antenna arrays; smart antennas; ground effects; multipath. ***Prerequisite: ELEE 490***

ELEE 555 RF System Engineering for Wireless Communications (3 Credit Hours)
This course introduces students to system blocks, system parameters, and architectures of RF systems for wireless communications. It focuses on the design of a radio system for transmission and reception of voice and data information: receivers and transmitters system topologies, key system blocks in a wireless system, determination of system block parameters from radio requirements and system analysis, tradeoffs between various blocks in a radio system, and frequency planning. It discusses how modulation and demodulation schemes and multiple-access techniques used in present wireless applications influence RF systems requirements. The last part of the course focuses the link budget analysis of RF radio links. ***Prerequisite: ELEE 536, ELEE 552***

ELEE 599 Research Methodology (3 Credit Hours)
Graduate students working towards the M.S. degree are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. ***Prerequisite: Graduate Standing***

ELEE 610 Research Thesis (9 Credit Hours)
The student has to undertake and complete a research topic under the supervision of a faculty member in order to analyze and solve a specific problem in the research area related to his/her specialization. ***Prerequisite: ELEE 599***

ELEE 611 Engineering Design Project (3 Credit Hours)
Application of knowledge and skills acquired during the study of the graduate program in the solution of open-ended, advanced level design problems from a technical, environmental and socio-economic viewpoint. Students can work with senior engineers from industry on a specific design project. ***Prerequisite: Advisor Consent***