ELECTRICAL ENGINEERING (ELEN)

ELEN 541 Digital Communication (3 Units)
Introduction to digital communication theory and systems. Sampling, formatting and baseband communications. Digital modulation techniques and optimal receivers. Error performance analysis. Error control coding. (Formerly 4400:541)

ELEN 545 Wireless Communications (3 Units)
Theory and analysis of wireless communication systems, wireless propagation, multiple access, modulation, demodulation, multipath channel characterization, diversity, cellular, and PCS services and standards. (Formerly 4400:545)

ELEN 548 Optical Communication Networks (3 Units)
Optical waveguides and optical integrated components, optical transmitters and receivers, optical communication network design. (Formerly 4400:548)

ELEN 553 Antenna Theory (3 Units)
Theory of EM radiation. Wire antennas, arrays, receiving antennas, reciprocity. Integral equations for induced currents, self and mutual impedances. Equivalent principle, radiation from aperture antennas. (Formerly 4400:553)

ELEN 555 Microwaves (4 Units)
Dynamic fields, Maxwell's equation and wave equations. Field analysis of wave guides, microwave components, techniques and systems. (Formerly 4400:555)

ELEN 561 Optical Electronics and Photonic Devices (3 Units)
Lightwave engineering, photonic principles and optical electronic device technology. (Formerly 4400:561)

ELEN 572 Control Systems II (4 Units)
State variable analysis, design of control systems. Discrete systems, analysis, digital computer control. Experiments include hybrid, AC control system, digital computer control. (Formerly 4400:572)

ELEN 583 Power Electronics I (3 Units)
Elements of power electronics circuits. Rectifiers, converters, inverters analysis and design. (Formerly 4400:583)

ELEN 584 Power Electronics Laboratory & Design Project (2 Units)
Prerequisite: ELEN 583 or equivalent. Experiments on different types of power electronic converters: AC/DC, DC/DC, DC/AD, and AC/AC. Design project to include design, simulation, building, and testing of a power electronic circuit. (Formerly 4400:584)

ELEN 585 Electric Motor Drives (3 Units)
Application of electric machines, choice of motor for particular drive. Application of power semiconductor circuits in electric machinery. (Formerly 4400:585)

ELEN 589 Design of Electric and Hybrid Vehicles (3 Units)
Prerequisite: Permission by Instructor. Principles of electric and hybrid vehicles. Characteristics of electric machines, engines, transmissions, batteries, fuel cells, ultracapacitors. Vehicle control strategies, communication networks, and overall system integration. (Formerly 4400:589)

ELEN 598 Special Topics: Electrical Engineering (1-3 Units)
(May be taken more than once.) Prerequisite: permission of department chair. Special topics in electrical engineering. (Formerly 4400:598)

ELEN 641 Random Signal Analysis (3 Units)
Analysis, interpretation and smoothing of engineering data through application of statistical and probability methods. (Formerly 4400:641)

ELEN 642 Imaging System Engineering (3 Units)
Prerequisite: ELEN 561. Engineering principles of imaging systems, analysis, design, and evaluation of imaging systems, processing techniques, and applications. (Formerly 4400:642)

ELEN 643 Information Theory (3 Units)
Source and channel models, entropy, relative entropy, mutual information, data compression, random coding bound and channel coding theorem, channel capacity for Gaussian channels, practical coding schemes, network information theory. (Formerly 4400:643)

ELEN 645 Advanced Wireless Communications (3 Units)
Advanced topics in wireless communications including MIMO, multiuser and cooperative communications. (Formerly 4400:645)

ELEN 646 Digital Signal Processing (3 Units)
Relations between continuous-and discrete-time Fourier expansions. Sampling, aliasing, sampling rate conversion. Operator concepts in signal processing, all-pass systems, FFT, digital filter design. (Formerly 4400:646)

ELEN 647 Digital Spectral Analysis & Signal Modeling (3 Units)
Prerequisites: ELEN 646 or permission of instructor. Methods and theory of spectral analysis and signal modeling are investigated in detail. Applications of theory include speech processing, optimal filtering, biomedical systems, digital communications. (Formerly 4400:647)

ELEN 648 Optical Network Architecture (3 Units)
Prerequisite: ELEN 548. Principles of optical network architecture, analysis, design, control, and fault management. (Formerly 4400:648)

ELEN 649 Error Control Coding (3 Units)
Error control coding techniques for communications including block codes, cyclic codes, convolutional codes, turbo codes, LDPC codes, coded modulation and iterative decoding. (Formerly 4400:649)

ELEN 650 Electromagnetic Theory I (3 Units)
Prerequisite: permission of instructor. Electrostatics: uniqueness theorem, boundary-value problems, constructions of Green's functions. Magnetostatics. Electrodynamics: energy and momentum, EM potentials, Stratton-Chu formulation, radiation, dyadic Green's functions. (Formerly 4400:650)

ELEN 651 Electromagnetic Theory II (3 Units)
Prerequisite: ELEN 650 or permission of the course instructor. Scattering; TEM waves; guided wave theory: transmission lines, closed-boundary guides and cavities, modal orthogonality and completeness, Green's function, excitation and coupling, open-boundary waveguides. (Formerly 4400:651)

ELEN 652 Computer Electromagnetics (3 Units)
Prerequisite: ELEN 650 or permission of the course instructor. Analytic and numerical techniques for electromagnetic fields, conformal mapping, finite difference method, finite element method, and the method of moments. (Formerly 4400:652)

ELEN 655 Advanced Antenna Theory & Design (3 Units)
Prerequisite: ELEN 553 or equivalent. Basic properties and recent advances of microstrip antennas. Analysis and design of reflector antennas. Analysis and synthesis of linear and planar antenna arrays. (Formerly 4400:655)

ELEN 663 Analog Circuits and Systems (3 Units)
Fundamental aspects of continuous-time and discrete-time analog signal processing circuits including amplifiers, comparators, filters, sample and holds, switched-capacitor circuits, time-mode circuits, sensor readout circuits, and energy harvesting circuits.

ELEN 666 Simulation of Nanoscale and Moleecular-Scale Systems (3 Units)
The course describes modern simulation techniques for the analysis of nano-scale phenomena: molecular dynamics, fast algorithms for multiatomic and multiparticle systems, and initio methods in electronic structure calculation. (Formerly 4400:666)

ELEN 673 Nonlinear Control (3 Units)
Corequisite: ELEN 674 or instructor permission. Designed to provide students with qualitative insights into nonlinear systems as well as techniques for controlling such systems. Topics include describing functions, Popov and circle criteria, jump resonances, subharmonics, phase plane, conservative systems, Lyapunov theory, bifurcation of attractors, and routes to chaos. (Formerly 4400:673)

ELEN 674 Control System Theory (3 Units)
Prerequisite: instructor permission. Advance modern control theory for linear systems. Controlability, observability, minimal realizations of multivariate systems, stability, state variable feedback, estimation, and an introduction to optimal control. (Formerly 4400:674)

ELEN 677 Optimal Control I (3 Units)
Prerequisite: ELEN 674. Formulation of optimizational problem; application of variational calculus, maximum principle and optimality principle to control problems. Computational techniques in optimization. (Formerly 4400:677)

ELEN 680 Dynamics & Control of Power Electronic Circuits (3 Units)
Prerequisites: ELEN 583 or equivalent. Averaged and sampled-data models for rectifiers and DC/DC converters. Small-and large-signal models about the cyclic steady-state. Feedback controls using classical and modern approaches. (Formerly 4400:680)

ELEN 686 Dynamics of Electric Machines (3 Units)
Prerequisites: graduate status in Electrical Engineering. Voltage and mechanical differential equations of electric machines, analytical and numerical methods for solution of a system of machine differential equations. (Formerly 4400:686)

ELEN 687 Power Electronics II (3 Units)
Prerequisite: ELEN 583 or equivalent. Effects of the nonidealities of the power circuit components, magnetics, base and gate drives, thyristor commutation circuits, heat transfer and thermal issues. Analysis and design of advanced power circuits. (Formerly 4400:687)

ELEN 688 Control of Electric Machines (3 Units)
Prerequisites: graduate student in Electrical Engineering. Elements of control circuits for electric drives, techniques for torque/speed control of electric machines. (Formerly 4400:688)

ELEN 689 Power Semiconductor Devices (3 Units)
Prerequisite: graduate status in Electrical Engineering. Structure and physics of power semiconductor devices: diodes, Bipolar junction transistors, MOSFETs, Thyristors, Power MOS-Bipolar devices (IGT,MCT). Emphasis on the issues that characterize these devices from the lower power semiconductor devices. (Formerly 4400:689)

ELEN 693 Special Problems: Electrical Engineering (1-3 Units)
(May be taken more than once) Prerequisite: permission of department chair. For a qualified graduate student. Supervised research or investigation in major field of training or experience. Credits dependent upon nature and extent of project. (Formerly 4400:693)

ELEN 693-1 Analog Circuits and Systems (1-3 Units)
Prerequisite: permission of department chair. The course will provide a broad-spectrum introduction of the fundamental principles of computer and network security. Topics will include security policies, models and mechanism for confidentiality, integrity and availability, access control, authorization, cryptography and applications, threats and vulnerabilities in computer networks, key management, firewalls and security services in computer networks. After completing the course, students will be able to: 1. understand basic security principles and apply them to the analysis of novel situations; 2. perform risk analysis for a computer/networked system; 3. apply appropriate security techniques for a given computer/networked system; 4. enumerate various protection techniques and the type of protection they provide; 5. point out the advantages and disadvantages of using different security protection mechanisms.

ELEN 693-2 High Voltage Engineering (1-3 Units)
Prerequisite: permission of department chair. The study of "electrical insulating materials" and how they operate under high electrical stress under various physical conditions is the fundamental focus of the field of "high voltage engineering." This course takes a fresh way of explaining the basic idea of field-dependent behavior of dielectrics under various high voltage conditions. This course starts with the classification of electric fields and their estimation techniques. This course has covered the performance and behavior of gaseous, solid, and liquid dielectrics in great detail. SF6 which is popularly used as insulating materials in switchgear systems, is identified as a greenhouse gas. For this reason, this course will introduce students to various alternatives to SF6 and their discharge procedures. Moreover, with the development of technologies with high power density, unforeseen dielectric challenges are emerging. Students will learn the conventional approaches and recently developed approaches to addressing these dielectric challenges. Furthermore, comprehensive coverage is also given to the fundamentals of high voltage laboratory techniques, non-destructive testing, and measuring high test voltages.

ELEN 697 Engineering Report (2 Units)
Prerequisite: Permission of advisor. Study of a relevant problem in Electrical and Computer Engineering for students electing the non-thesis Master's option. (Formerly 4400:697)

ELEN 698 Master's Research: Electrical Engineering (1-6 Units)
Prerequisite: Permission of advisor. (May be repeated.) Research on a suitable topic in electrical engineering culminating in a master's thesis. (Formerly 4400:698)

ELEN 699 Master's Thesis (1-6 Units)
Prerequisite: permission of department chair. Research and thesis on some suitable topic in electrical engineering. (Formerly 4400:699)

ELEN 753 Topics in Electromagnetics (3 Units)
Prerequisite: ELEN 651. Introduction to advanced techniques in fields. Topics include application of Green's function techniques and related boundary value problems. (Formerly 4400:753)

ELEN 772 Model Reduction Techniques for Control Systems (3 Units)
Prerequisite: ELEN 674 or permission of the instructor. Classical, modern, and optimal techniques for computing reduced order models of linear, nonlinear, and infinite dimensional systems. Minimal realizations of multi-variable systems are also considered. (Formerly 4400:772)

ELEN 774 Advanced Linear Control Systems (3 Units)
Prerequisite: ELEN 674 and a course in Real Analysis or equivalent. Covers topics related to the design of robust control systems. The synthesis of controllers which yield stable closed-loop systems will be considered. The H8-optimality criterion for controller design is included. Special emphasis will be given to the robust stabilization problem and the disturbance attenuation problem. (Formerly 4400:774)

ELEN 775 Robust Control (3 Units)
Prerequisite: ELEN 674. Input-output and state-space characterizations of robust control systems, and design techniques based on the algebraic Riccati equation. Decentralized and reliable control design methodologies. (Formerly 4400:775)

ELEN 777 Optimal Control II (3 Units)
Prerequisite: ELEN 677. Advanced state-feedback optimal control. Output-feedback issues, including loop transfer recovery, optimal observer design, reduced-order controllers, frequency weighting, and decentralized control. (Formerly 4400:777)

ELEN 778 Adaptive Control (3 Units)
Prerequisite: Permission of instructor. This course will provide the advanced graduate student with the techniques required for the control of time-varying nonlinear and stochastic systems. Topics include minimum prediction error control, least squares estimation, certainty equivalence adaptive control. Kalman filtering, minimum variance control, LQG control and stochastic adaptive control. (Formerly 4400:778)

ELEN 779 Advanced Topics in Control (3 Units)
Prerequisite: ELEN 677. Discussions of recent advances in control systems. (Formerly 4400:779)

ELEN 794 Advanced Seminar: Electrical Engineering (1-3 Units)
(May be taken more than once) Prerequisite: permission of department chair. Advanced level coverage of specialized topics. For student seeking Ph.D. in engineering. (Formerly 4400:794)

ELEN 898 Preliminary Research (1-15 Units)
(May be repeated.) Prerequisite: approval of dissertation director. Preliminary investigations prior to submission of a dissertation proposal to the Interdisciplinary Doctoral Committee. (Formerly 4400:898)

ELEN 899 Doctoral Dissertation (1-15 Units)
(May be repeated.) Prerequisite: acceptance of research proposal by the Interdisciplinary Doctoral Committee and approval of the dissertation director. Original research by the doctoral student. (Formerly 4400:899)