

ELECTRICAL ENGINEERING (EE)

EE 500: Colloquium

1 Credits

Continuing seminars that consist of a series of individual lectures by faculty, students, or outside speakers.

EE 510: Linear Integrated Circuits

3 Credits

Design of monolithic, thin-film, and hybrid linear integrated circuits; D.C., video, tuned, r.f., and microwave applications. Emphasis on reliability.

Prerequisite: E E 410 ; E E 441

EE 520: Electro Optics--Systems and Computing

3 Credits

Synthetic aperture radar, spatial light modulators, optical interconnection, optical computing, neural networks, and medical optics imaging.

Prerequisite: E E 420

EE 521: Fiber Optics and Integrated Optics

3 Credits

Theories and applications of linear and nonlinear optical phenomena in optical fibers and integrated optical devices.

Prerequisite: E E 421

EE 522: Electro-Optics Laboratory

3 Credits

Basic concepts and fundamentals of light diffraction, optical signal processing, and holography.

Prerequisite: E E 420

EE 524: Lasers and Optical Electronics

3 Credits

Study of several advanced nonlinear optical phenomena, laser propagation, optical and optoelectronic devices, principles, and applications.

Prerequisite: E E 424

EE 526: Nonlinear Optical Materials

3 Credits

Mechanisms of polarization nonlinearity, nonlinear optical processes and analyses, optoelectronic materials and their device application. E E (MATSE) 526 Nonlinear Optical Materials (3) Nonlinear Optical Materials is a course that will generally be offered in spring semesters. It is designed for students who are interested in the materials science-related interdisciplinary electronics/electro-optic engineering areas to provide an essential understanding of the mechanisms of the polarization

nonlinearity in electronic materials as well as the principles of operation of these materials in various photonic and optoelectronic applications (e.g., frequency conversion, optical control/communication, and information storage). Analytical methods utilizing the electromagnetic wave theories and tensor operations will be covered in this course to treat anisotropic nonlinear optical materials for their wave-matter interaction processes and to enable device designs. Technological issues in research and development of advanced optoelectronic devices using nonlinear optical materials are discussed with students' participation. Students wishing to take this course should be familiar with optical properties of materials and basic tensor notations.

Prerequisite: E E 420 or MATSE435

Cross-Listed

EE 531: Engineering Electromagnetics

3 Credits

Electromagnetic field theory fundamentals with application to transmission lines, waveguides, cavities, antennas, radar, and radio propagation.

Prerequisite: E E 430

EE 534: Conformal Antennas

3 Credits

Introduction to advanced analysis and design techniques as well as applications for conformal antennas mounted on planar and curved surfaces. E E 534 Conformal Antennas (3) E E 534 provides an introduction to the rapidly growing field of conformal antennas. Analysis and design techniques are presented for conformal antennas mounted on planar as well as curved surfaces. Important applications of conformal antennas are also discussed with emphasis on their recent popularity as wireless PCS, GPS, and body-borne antennas. Microstrip antenna design projects will be assigned, where students will gain valuable experience using one or more commercially available industry-standards modeling codes. E E 534 is the third and most advanced course in a three-course sequence of antenna engineering courses: E E 438 (Antenna Engineering), E E 538 (Antenna Engineering) and E E 534. E E 534 will be taught every other fall semester, with an anticipated enrollment of 20-30 students.

Prerequisite: E E 538

EE 535: Boundary Value Methods of Electromagnetics

3 Credits

Theory and application of boundary value problems in engineering electromagnetics; topics include microwave and optical waveguides, radiation, and scattering.

Prerequisite: E E 430 or E E 432 or E E 438 or E E 439

EE 537: Numerical and Asymptotic Methods of Electromagnetics

3 Credits

Finite difference time domain, geometric theory of diffraction and method of moments applied to antennas and scattering.

EE 538: Antenna Engineering

3 Credits

In-depth studies of synthesis methods, aperture sources, broadband antennas, and signal-processing arrays.

Prerequisite: E E 438

EE 541: Manufacturing Methods in Microelectronics

3 Credits

Methods, tools, and materials used to process advanced silicon integrated circuits.

Prerequisite: E E 441

Cross-Listed

EE 542: Semiconductor Devices

3 Credits

Characteristics and limitations of bipolar transistors, diodes, transit time, and bulk-effect devices.

Prerequisite: E E 442

EE 543: Ferroelectric Devices

3 Credits

Theoretical background of ferroelectric devices, practical materials, device designs, drive/control techniques, and typical applications.

EE 544: Micromechatronics

3 Credits

Theoretical background of solid state actuators, practical materials, device designs, drive/control techniques and typical applications.

EE 545: Semiconductor Characterization

3 Credits

Physical principles and experimental methods used to characterize the electrical, optical, structural and chemical properties of semiconductor materials.

Cross-listed with: MATSE 545

EE 546: Field-Effect Devices

3 Credits

The physical background, characteristics, and limitations of surface field-effect and junction field-effect devices and related structures.

Prerequisite: E E 442

EE 547: Dielectric Devices

3 Credits

Applications of insulator physics and devices based on insulator properties.

Prerequisite: E E 442

EE 549: Acoustic Wave Devices

3 Credits

Examines materials commonly used for acoustic wave devices, fundamentals of acoustic waves and resonance modes, and characteristics of these devices. E E 549 Acoustic Wave Devices (3) E E 549 is an elective in the field of electronic and photonic materials. Solid state acoustic wave devices based on piezoelectric, ferroelectric, and microelectromechanical systems (MEMS) have a broad range of applications including chemical and biological sensors, electromechanical sensing and transduction, resonators and wave guides for material characterization and health monitoring, filters in telecommunication systems, and optic communications. The course will cover commonly used materials and phenomena for acoustic wave devices, characteristics of different waves and vibration modes, device configurations, their main characteristics and applications, as well as design considerations. Students will learn the key features and materials commonly used for acoustic wave devices, main acoustic mode and their characteristics, important device configurations, the equivalent circuits for acoustic wave modes and devices, and examples of the device applications. Students will also acquire basic skills in selecting acoustic wave devices for specific applications, in designing and characterizing acoustic wave devices for different applications, and in finding suitable available materials and/or phenomena for the acoustic wave device. This course will count as an elective for electrical engineering students in the electronics and photonics sub-discipline. Students wishing to take this course should be familiar with electronic circuit design and solid state devices.

Prerequisite: E E 310 and E E 442

EE 550: Foundations of Engineering Systems Analysis

3 Credits

Analytical methods are developed using the vector space approach for solving control and estimation problems; examples from different engineering applications. E E (M E) 550 Foundations of Engineering Systems Analysis (3) This 3-credit course is offered at the first-year graduate level and provides a systems-theoretic background for more advanced graduate courses in the disciplines of engineering and science. The course uses the vector space approach to develop the analytical foundations for solutions of science and engineering problems in diverse application areas such as optimal control, estimation, and signal processing. First, the theoretical foundation of vector spaces, function spaces, and Hilbert spaces are developed. Linear transformations are then introduced, followed by the Reisz-Frechet theorem and Hahn-Banach theorem, with applications to optimization problems. Spectral analysis is then covered. Finally, diverse applications of these various techniques are presented throughout this course to illustrate the wide range of engineering problems that can be solved using the vector space approach.

Prerequisite: MATH 436

Cross-listed with: ME 550

EE 551: Wavelets and Sparse Signal Representations

3 Credits

Recommended Preparations: Linear algebra This course provides the foundation to understand and use wavelets and sparse signal representations. In particular, it develops sparse representations as an

evolution of the discrete wavelet transform. Students will recognize, identify, and apply sparse and wavelet representations methodology to specific signal processing projects. Students will be shown multiple real world applications within this area and guided to apply the methodologies combined with their own domain knowledge.

Prerequisite: EE 453

EE 552: Pattern Recognition—Principles and Applications

3 Credits

Decision-theoretic classification, discriminant functions, pattern processing and feature selection, syntactic pattern recognition, shape analysis and recognition.

Cross-listed with: CSE 583

EE 553: Topics in Digital Signal Processing

3 Credits

Parametric modeling, spectral estimation, efficient transforms and convolution algorithms, multirate processing, and selected applications involving non-linear and time-variant filters.

Prerequisite: E E 453

EE 554: Topics in Computer Vision

3 Credits

Discussion of recent advances and current research trends in computer vision theory, algorithms, and their applications.

Prerequisite: CMPEN454 or E E 454

Cross-listed with: CSE 586

EE 555: Digital Image Processing II

3 Credits

Advanced treatment of image processing techniques; image restoration, image segmentation, texture, and mathematical morphology.

Prerequisite: CMPEN455 or E E 455

Cross-listed with: CSE 585

EE 556: Graphs, Algorithms, and Neural Networks

3 Credits

Examine neural networks by exploiting graph theory for offering alternate solutions to classical problems in signal processing and control.

EE 557: Multidimensional Signal Processing

3 Credits

Multidimensional sampling, weak causality, recursibility, multidimensional transforms, stability, global and local state-space models, multidimensional filters, and multidimensional spectrum estimation.

Prerequisite: E E 453

EE 560: Probability, Random Variables, and Stochastic Processes

3 Credits

Review of probability theory and random variables; mathematical description of random signals; linear system response; Wiener, Kalman, and other filtering.

Prerequisite: E E 350 ; STAT 418

EE 561: Information Theory

3 Credits

Mathematical measurement of information; information transfer in discrete systems; redundancy, efficiency, and channel capacity; encoding systems.

Prerequisite: E E 460 ; STAT 418

EE 562: Detection and Estimation Theory

3 Credits

Detection decision theory, Bayes and Neyman-Pearson criteria, optimal receivers, classical estimation theory, signal-noise representations, optimum linear signal parameters estimation.

Prerequisite: E E 560

EE 564: Error Correcting Codes for Computers and Communication

3 Credits

Block, cyclic, and convolutional codes. Circuits and algorithms for decoding. Application to reliable communication and fault-tolerant computing.

Prerequisite: Communication Networks

Cross-listed with: CSE 554

EE 565: Reliable Data Communications

3 Credits

Discussion of problems and solutions for ensuring reliable and efficient communication over wired and wireless links and data networks.

Prerequisite: Communication Networks; STAT 418

Cross-listed with: CSE 515

EE 567: Wireless and Mobile Communications

3 Credits

Development of key wireless networks systems analysis and design tools utilizing telecommunications principles; current and emerging mobile wireless techniques. E E 567 Wireless and Mobile Communications (3) E E 567, Wireless and Mobile Communications, extends basic principles of communications systems and their associated performance into the world of wireless and mobile communications. This course has been designed primarily to provide a good understanding of fundamental problems and counter-measure techniques in digital communications over dispersive wireless mobile channels. It starts with a review of material necessary for advanced study in wireless communications: current wireless mobile systems and standards, frequency reuse and the cellular concept, co-channel interference and noise, receiver sensitivity and link budget calculations, coverage, and spectral efficiency and

capacity. Next, various types of propagation modeling are presented, such as large-scale fading, small-scale fading, and multiple scattering (multi-path) phenomena. Examples of Rayleigh, Rician, and Nakagami fading channels are discussed, and level crossing rates and fade durations are determined. This is followed by methods for developing laboratory fading channel simulators for both single- and multiple-path channel models, including the laboratory simulation of shadowing. Conventional path-loss models in macro-cells such as Okumura-Hata and outdoors micro-cells, COST231-Hata, and Walfish-Ikegami models as well as path loss for indoor micro-cells are then detailed. The next part of the course covers fundamental limits introduced by co-channel interference, as multiple lognormal interferers are introduced. Specifically, Fenton-Wilkinson, Schwartz and Yeh, Farley's methods and a numerical comparison are presented. Outage probability evaluation is detailed. Modulation techniques used in wireless mobile applications and associated performance over fading channels are reviewed next, followed by a detailed investigation of diversity and combining techniques. TDMA and CDMA Cellular systems are presented next. Topics covered here include: Spread spectrum systems including direct sequence, frequency hopping, fading channel applications, RAKE receiver concepts, multi-input-multi-output (MIMO) systems using antenna arrays, space-time coding and BLAST systems. As examples of mobile cellular architectures, TDMA (GSM) and CDMA cellular systems are covered. Finally, in order to initiate hard or soft handoffs, link quality measurement techniques are discussed. Optimal resource allocation in terms of channel assignment techniques are presented and analyzed. Students will be evaluated by means of assignments (25%), a mid-semester examination (35%), and a final examination (40%). The course will be offered every other spring, with an anticipated enrollment of 15-30 students.

Prerequisite: E E 460 ; E E 560

EE 568: Digital Communications I

3 Credits

Linear and nonlinear digital modulation techniques; performance in additive Gaussian noise channel; continuous phase modulation; carrier acquisition and recovery.

Prerequisite: E E 460; Concurrent: E E 560

EE 569: Digital Communications II

3 Credits

Baseband pulse transmission; baseband systems optimization; bandlimited channels performance in ISI; equalization; MLSE and ISI; fading channels; diversity; CDMA.

Prerequisite: E E 560 ; E E 568

EE 573: Constitution of the Ionosphere

3 Credits

Properties of neutral and ionized atmosphere above 60 km; photochemical processes; solar, meteoric perturbations of the ionosphere; large-scale movements in ionization.

EE 574: Propagation Through Random Media

3 Credits

RF/optical wave propagation through turbulent, turbid, and heterogeneous media (atmosphere/ionosphere/sea). Impacts and mitigation discussed for various scenarios.

Prerequisite: E E 430 or E E 439 or E E 477 or PHYS 457

EE 576: Inversion Techniques in Remote Sensing

3 Credits

Introduce skills to address a wide variety of inverse problems such as found in atmospheric sensing, geosciences, and acoustics.

Prerequisite: E E 430 or E E 439 or E E 477 ; STAT 418

EE 578: Radar Systems

3 Credits

This course provides a general understanding of radar systems at the graduate level, building upon material covered in undergraduate courses in electromagnetics, signals and systems, and antenna theory. In particular, it investigates the theory of radar systems and subsystems, and continues with the analysis of the radar equation, target detection in noise, and clutter phenomena. It includes radar techniques to enhance high range resolution of targets such as pulse compression. It also considers radar tracking, synthetic aperture radar, radar polarimetry, target recognition, scattering process, radar signal processing, electronic counter-measure techniques, and laser radar. Building on these concepts, students will understand the usage and applications of various types of radar system designs. Students will understand propagation, multi-path, and clutter phenomena and their effects on radar system performance. Students will recognize, identify, and apply proper radar techniques and apply these techniques to a variety of remote sensing radar applications.

EE 430 and (EE 432; EE 438; EE 439) and (EE 453; EE 460)

EE 579: Microwave Radar Remote Sensing

3 Credits

Scientific and engineering principles of microwave radar remote sensing of land, sea, and the atmosphere.

Prerequisite: E E 430 or E E 438 or E E 439 or E E 473

EE 580: Linear Control Systems

3 Credits

Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability.

Prerequisite: E E 380

EE 581: Optimal Control

3 Credits

Variational methods in control system design; classical calculus of variations, dynamic programming, maximum principle; optimal digital control systems; state estimation.

Prerequisite: E E 580

EE 582: Adaptive and Learning Systems

3 Credits

Adaptive and learning control systems; system identification; performance indices; gradient, stochastic approximation, controlled random search methods; introduction to pattern recognition.

Prerequisite: E E 580

EE 584: Robust Control Theory

3 Credits

Fundamentals of Robust Control Theory with emphasis on stability, performance analysis, and design.

Prerequisite: E E 580 or M E 555

Cross-listed with: ME 558

EE 587: Nonlinear Control and Stability

3 Credits

Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability.

Prerequisite: E E 380

Cross-listed with: ME 559

EE 588: Power System Control and Operation

3 Credits

Steady-state and dynamic model of synchronous machines, excitation systems, unit commitment, control of generation, optimal power flow.

Prerequisite: E E 488

EE 594: Research Projects

1-9 Credits/Maximum of 9

Supervision of individual research projects leading to M.S. or M.Eng. papers. Written and oral reports are required.

EE 596: Individual Studies

1-9 Credits/Maximum of 9

Creative projects including non-thesis research which are supervised on an individual basis and which fall outside the scope of formal courses.

EE 597: Special Topics

1-9 Credits/Maximum of 9

Formal courses given on a topical or special interest subject which may be offered infrequently.

EE 600: Thesis Research

1-15 Credits/Maximum of 999

No description.

EE 601: Ph.D. Dissertation Full-Time

0 Credits/Maximum of 999

No description.

EE 602: Supervised Experience in College Teaching

3 Credits/Maximum of 6

College Teaching Experience

EE 610: Thesis Research Off Campus

1-15 Credits/Maximum of 999

No description.

EE 611: Ph.D. Dissertation Part-Time

0 Credits/Maximum of 999

No description.