ELECTRICAL AND COMPUTER ENGINEERING (ECEN)

Electrical and Computer Engineering Graduate Courses

ECEN 800 ELECTRONIC INSTRUMENTATION (3 credits)
Applications of analog and digital devices to electronic instrumentation. Includes transducers, instrumentation amplifiers, mechanical and solid state switches, data acquisition systems, phase-lock loops, and modulation techniques. Demonstrations with working circuits and systems. (Cross-listed with ECEN 400)
Prerequisite(s): Senior Standing in Engineering or Permission. Not open to non-degree graduate students.

ECEN 806 POWER SYSTEMS ANALYSIS (3 credits)
Symmetrical components and fault calculations, power system stability, generator modeling (circuit view point), voltage control system, high voltage DC transmission, and system protection. (Cross-listed with ECEN 406)
Prerequisite(s): ECEN 338. Not open to non-degree graduate students.

ECEN 807 POWER SYSTEMS PLANNING (3 credits)
Economic evaluation, load forecasting, generation planning, transmission planning, production simulation, power plant reliability characteristics, and generation system reliability. (Cross-listed with ECEN 407)
Prerequisite(s): ECEN 305. Not open to non-degree graduate students.

ECEN 808 ENGINEERING ELECTROMAGNETICS (3 credits)
Applied electromagnets: Transmission lines in digital electronics and communication. The quasistatic electric and magnetic fields; electric and magnetic circuits and electromechanical energy conversion. Guided waves; rectangular and cylindrical metallic waveguides and optical filters. Radiation and antennas; line and aperture antennas and arrays. (Cross-listed with ECEN 408)
Prerequisite(s): ECEN 306. Not open to non-degree graduate students.

ECEN 810 MULTIVARIATE RANDOM PROCESSES (3 credits)
Probability space, random vectors, multivariate distributions, moment generating functions, conditional expectations, discrete and continuous-time random processes, random process characterization and representation, linear systems with random inputs. (Cross-listed with ECEN 410)
Prerequisite(s): ECEN 305. Not open to non-degree graduate students.

ECEN 815 DIGITAL IMAGE PROCESSING (3 credits)
Topics covering the spatial and spectral analysis of digital image processing systems, the design of multi-dimensional digital filters and systems, and advanced theories and technologies in digital image processing systems.
Prerequisite(s): ECEN 424 or ECEN 824 or permission.

ECEN 816 MATERIALS AND DEVICES FOR COMPUTER MEMORY, LOGIC, AND DISPLAY (3 credits)
Survey of fundamentals and application of devices used for memory, logic, and display. Magnetic, superconductive, semi-conductive, and dielectric materials. (Cross-listed with ECEN 416)
Prerequisite(s): PHYS 2120, not open to non-degree graduate students.

ECEN 817 SEMICONDUCTOR FUNDAMENTALS II (3 credits)
Analysis of BJT's and MOSFET's from a first principle materials viewpoint. Statics and dynamic analysis and characterization. (Cross-listed with ECEN 417.)
Prerequisite(s): ECEN 421 or ECEN 821. Not open to non-degree graduate students.

ECEN 820 PLASMA PROCESSING OF SEMICONDUCTORS (3 credits)
Physics of plasmas and gas discharges developed. Includes basic collisional theory, the Boltzman equation and the concept of electron energy distribution. Results are related to specific gas discharge systems used in semiconductor processing, such as sputtering, etching, and deposition systems. (Cross-listed with ECEN 420)
Prerequisite(s): Senior or graduate Standing. Not open to non-degree graduate students.

ECEN 821 PRINCIPLES OF SEMICONDUCTOR MATERIALS AND DEVICES I (3 credits)
Introduction to semiconductor fundamentals, charge carrier concentration and carrier transport, energy bands, and recombination. PN junction, static and dynamic, and special PN junction diode devices. (Cross-listed with ECEN 421)
Prerequisite(s): PHYS 2130. Not open to non-degree graduate students.

ECEN 824 DIGITAL SIGNAL PROCESSING (3 credits)
The temporal and spectral analysis of digital signals and systems, the design of digital filters and systems, and advanced systems including multi-rate digital signal processing techniques. (Cross-listed with ECEN 424)
Prerequisite(s): ECEN 355

ECEN 828 POWER ELECTRONICS (4 credits)
Basic analysis and design of solid-state power electronic devices and converter circuitry. (Cross-listed with ECEN 428)
Prerequisite(s): ECEN 304, ECEN 316.

ECEN 830 WIND ENERGY (3 credits)
This broad multidisciplinary course will combine engineering principles of both the mechanical/aerodynamical and electrical components and systems, along with economic and environmental considerations for siting and public policy, to appropriately cover the relevant topics associated with all scales of wind energy implementations. (Cross-listed with ECEN 430)
Prerequisite(s): Senior standing or permission.

ECEN 833 MICROPROCESSOR SYSTEM DESIGN (4 credits)
Microprocessor based systems. Architecture; design and interfacing. Memory design, input/output ports, serial communications, and interrupts. Generating assembly ROM code, assembly/C firmware generation, and designing device drivers. (Cross-listed with ECEN 433)
Prerequisite(s): ECEN 310 with grade of C or better and ECEN 332 with grade of C or better.

ECEN 835 EMBEDDED MICROCONTROLLER DESIGN (4 credits)
Microcontroller architecture: design, programming, and interfacing for embedded systems. Timing issues, memory interfaces, serial and parallel interfacing, and functions for common microcontrollers. (Cross-listed with ECEN 435)
Prerequisite(s): ECEN 433/ECEN 833, STAT 3800. Pre- or co-req: CSCI 4500.

ECEN 836 ELECTRIC MACHINES (3 credits)
Provides a solid background in electric machine analysis, covering fundamental concepts, techniques, and methods for analysis and design. Discussion of transformers and presentation of some new systems and applications. (Cross-listed with ECEN 436).
Prerequisite(s): PHYS 2120 and ECEN 216

ECEN 837 PARALLEL AND DISTRIBUTED PROCESS (3 credits)
Parallel and Distributed Processing concepts, principles, techniques and machines. (Cross-listed with ECEN 437).
Prerequisite(s): ECEN 435 or ECEN 835

ECEN 842 BASIC ANALYTICAL TECHNIQUES IN ELECTRICAL ENGINEERING (3 credits)
Applications of partial differential equations, matrices, vector analysis, complex variables, and infinite series to problems in electrical engineering. (Cross-listed with ECEN 442)
Prerequisite(s): MATH 2350. Not open to non-degree graduate students.

ECEN 844 LINEAR CONTROL SYSTEMS (3 credits)

Classical (transfer function) and modern (state variable) control techniques. Both time domain and frequency domain techniques are studied. Traditional, lead, lag, and PID compensators are examined, as well as state variable feedback. (Cross-listed with ECEN 444)
Prerequisite(s): ECEN 304. Not open to non-degree graduate students.

ECEN 848 DECISION ANALYSIS (3 credits)

Principles of engineering economy including time value of money, net present value, and internal rate of return. Use of influence diagram and decision tree to structure and analyze decision situations under uncertainty including use of stochastic dominance, value of information, and utility theory. Fundamentals of two-person matrix games including Nash equilibrium. (Cross-listed with ECEN 448)
Prerequisite(s): ECEN 305 or STAT 3800

ECEN 850 BIOINFORMATICS (3 credits)

This course examines how information is organized in biological sequences such as DNA and proteins and will look at computational techniques which make use of this structure. During this class various biochemical processes that involve these sequences are studied to understand how these processes effect the structure of these sequences. In the process bioinformatics algorithms, tools, and techniques which are used to explore genomic and amino acid sequences are also introduced. (Cross-listed with ECEN 450)
Prerequisite(s): Computer programming language and ECEN 305 or STAT 3800 or equivalent.

ECEN 851 INTRODUCTION TO VLSI SYSTEM DESIGN (3 credits)

The concepts, principles, and methodology at all levels of digital VLSI system design and focused on gate-level VLSI implementation. (Cross-listed with ECEN 451).
Prerequisite(s): ECEN 310

ECEN 852 INTRODUCTION TO COMPUTER-AIDED DIGITAL DESIGN (3 credits)

The concepts, simulation techniques and methodology in computer-aided digital design at system and logic levels. (Cross-listed with ECEN 452)
Prerequisite(s): ECEN 310

ECEN 853 COMPUTATIONAL AND SYSTEMS BIOLOGY (3 credits)

Provides the required biology primer and covers functional genomics, transcriptomics, differential expression, clustering, classification, prediction, biomarker discovery, pathway analysis and network based approaches to high throughput biological data analysis. Includes the development of databases, algorithms, web-based and other tools regarding management and analysis of life science data. Areas of study include DNA, RNA, and protein sequence analysis, functional genomics and proteomics, 3D macromolecule structure prediction, and systems/network approach. (Cross-listed with ECEN 453).
Prerequisite(s): By permission.

ECEN 854 POWER SYSTEMS OPERATION AND CONTROL (3 credits)

Characteristics and generating units. Control of generation, economic dispatch, transmission losses, unit commitment, generation with limited supply, hydrothermal coordination, and interchange evaluation and power pool. (Cross-listed with ECEN 454)
Prerequisite(s): ECEN 838. Not open to non-degree graduate students.

ECEN 860 LABVIEW PROGRAMMING (3 credits)

Labview as a programming language and for applications to acquire data, to access the network, control lab instruments, and for video and sound applications. (Cross-listed with ECEN 460)
Prerequisite(s): Prior programming experience.

ECEN 862 COMMUNICATION SYSTEMS (3 credits)

Mathematical descriptions of signals in communication systems. Principles of analog modulation and demodulation. Performance analysis of analog communication systems in the presence of noise. (Cross-listed with ECEN 462)
Prerequisite(s): ECEN 304 and ECEN 305. Not open to non-degree graduate students.

ECEN 863 DIGITAL SIGNAL PROCESSING (3 credits)

Discrete system analysis using Z-transforms. Analysis and design of digital filters. Discrete Fourier transforms. (Cross-listed with ECEN 463)
Prerequisite(s): ECEN 304. Not open to non-degree graduate students.

ECEN 864 DIGITAL COMMUNICATION SYSTEMS (3 credits)

Principles of digital transmission of information in the presence of noise. Design and analysis of baseband PAM transmission systems and various carrier systems including ASK, FSK, PSK. (Cross-listed with ECEN 464)
Prerequisite(s): ECEN 462. Not open to non-degree graduate students.

ECEN 865 INTRODUCTION TO DATA COMPRESSION (3 credits)

Introduction to the concepts of Information Theory and Redundancy removal. Simulation of various data compression schemes such as Delta Modulation, Differential Pulse Code Modulation, Transform Coding and Runlength Coding. (Cross-listed with ECEN 465)
Prerequisite(s): ECEN 305. Not open to non-degree graduate students.

ECEN 866 TELECOMMUNICATION ENGINEERING I (4 credits)

Standard telecommunications protocols, architecture of long distance integrated data networks, local area networks, wide area networks, radio and satellite networks. Network management, internetworking, system modeling and performance analysis. (Cross-listed with ECEN 466).
Prerequisite(s): ECEN 362; ECEN 461/ECEN 861 prior to or concurrent.

ECEN 867 ELECTROMAGNETIC THEORY AND APPLICATIONS (3 credits)

Engineering application of Maxwell's equations. Fundamental Parameters of Antennas, Radiation analysis, and synthesis of antenna arrays. Aperture Antennas. (Cross-listed with ECEN 467)
Prerequisite(s): ECEN 306. Not open to non-degree graduate students.

ECEN 868 MICROWAVE ENGINEERING (3 credits)

Applications of active and passive devices to microwave systems. Includes impedance matching, resonators, and microwave antennas. (Cross-listed with ECEN 468)
Prerequisite(s): ECEN 306. Not open to non-degree graduate students.

ECEN 869 ANALOG INTEGRATED CIRCUITS (3 credits)

Analysis and design of analog integrated circuits both bipolar and MOS. Basic circuit elements such as differential pairs, current sources, active loads, output drivers used in the design of more complex analog integrated circuits. (Cross-listed with ECEN 469)
Prerequisite(s): ECEN 361. Not open to non-degree graduate students.

ECEN 870 DIGITAL AND ANALOG VLSI DESIGN (3 credits)

Introduction to VLSI design techniques for analog and digital circuits. Fabrication technology and device modeling. Design rules for integrated circuit layout. LSI design options with emphasis on the standard cell approach of digital and analog circuits. Lab experiments, computer simulation and layout exercises. (Cross-listed with ECEN 470)
Prerequisite(s): ECEN 361. Not open to non-degree graduate students.

ECEN 871 COMPUTER COMMUNICATION NETWORKS (4 credits)

This course investigates the standard protocols and hardware solutions defined by the International Standard Organization (ISO) and Institute of Electrical and Electronics Engineers (IEEE) for the computer communications networks. Included are ISO OSI model, IEEE 802.X (Ethernet, token bus, token ring) and Asynchronous Transfer Modals (ATM) networks. (Cross-listed with ECEN 471)
Prerequisite(s): ECEN 325

ECEN 872 IMAGE UNDERSTANDING, PERCEPTION, AND SIGNAL PROCESSING (3 credits)

Introduces fundamental principles and theory for computer vision, image understanding, and pattern recognition, perception, and signal processing. Specific attention given to analysis of the geometric properties and appearance of objects in images, such as region size, connectedness, topology, color, and texture. (Cross-listed with ECEN 472).
Prerequisite(s): ECEN 304 or graduate standing

ECEN 873 MOBILE AND PERSONAL COMMUNICATIONS (4 credits)

This course provides basic concepts on mobile and personal communications. Concepts on mobile and personal communications. Modulation techniques for mobile radio, equalization, diversity, channel coding, and speech coding. (Cross-listed with ECEN 473)
Prerequisite(s): ECEN 325

ECEN 874 DIGITAL SYSTEMS (3 credits)

Synthesis using state machines; design of digital systems; micro programming in small controller design; hardware description language for design and timing analysis. (Cross-listed with ECEN 474)
Prerequisite(s): ECEN 370. Not open to non-degree graduate students.

ECEN 875 SATELLITE COMMUNICATIONS (4 credits)

The fundamental concepts of satellite communications. Orbits, launching satellites, modulation and multiplexing, multiple access, earth stations, coding, interference and special problems in satellite communications. (Cross-listed with ECEN 475)
Prerequisite(s): ECEN 325

ECEN 876 WIRELESS COMMUNICATIONS (3 credits)

The fundamental concepts of wireless communications. Basic communications concepts such as multiple access, and spectrum. Propagation, radio, standards, and internetworking. Current issues in wireless communications. (Cross-listed with ECEN 476)
Prerequisite(s): ECEN 325 or ECEN 462 prior to or concurrent

ECEN 877 DIGITAL SYSTEMS ORGANIZATION AND DESIGN (3 credits)

Hardware development languages, hardware organization and realization, microprogramming, interrupt, intersystem communication, and peripheral interfacing. (Cross-listed with ECEN 477)
Prerequisite(s): ECEN 475 or ECEN 874. Not open to non-degree graduate students.

ECEN 878 PRACTICAL MACHINE LEARNING (3 credits)

Designed to provide a solid grasp of the methods of machine learning (ML) and how to build powerful ML models for discovering statistical regularities from both structured and unstructured data. Offers an introduction to Deep Learning for Computer Vision and Natural Language Processing. (Cross-listed with ECEN 478).

ECEN 879 OPTICAL FIBER COMMUNICATIONS (4 credits)

Fundamentals of lightwave communication in optical fiber waveguides, physical description of fiber optic systems. Properties of the optical fiber and fiber components. Electro-optic devices: light sources and modulators, detectors and amplifiers; optical transmitter and receiver systems. Fiber optic link design and specification; fiber optic networks. (Cross-listed with ECEN 479)
Prerequisite(s): ECEN 461/ECEN 861 or permission

ECEN 880 INTRODUCTION TO LASERS AND LASER APPLICATIONS (3 credits)

Physics of electronic transition production stimulated emission of radiation. Threshold conditions for laser oscillation. Types of lasers and their applications in engineering. (Cross-listed with ECEN 480)
Prerequisite(s): PHYS 2130.

ECEN 882 ANTENNAS AND RADIO PROPAGATION FOR WIRELESS COMMUNICATIONS (4 credits)

Fundamental theory of antennas and radio propagation for wireless communications. Basic antenna characteristics and various antennas and antenna arrays. Basic propagation mechanisms and various channel models, such as Friis free space model, Hata model, lognormal distribution, and multipath model. Includes practical antenna design for high radio frequency (RF) with modeling software tools such as Numerical Electromagnetic Code (NEC) and ADvanced Design System (ADS). Design projects will be assigned as the main part of course. (Cross-listed with ECEN 482)
Prerequisite(s): ECEN 328

ECEN 883 RANDOM PROCESSES IN ENGINEERING (3 credits)

Topics related to the concept of random variables, functions of random variables and random processes.
Prerequisite(s): STAT 3800

ECEN 884 NETWORK SECURITY (4 credits)

Network security and cryptographic protocols. Classical encrypytion techniques, block ciphers and stream cyphers, public-key cryptography, authentications digital signatures, key management and distributions, network vulnerabilities, transport-level security, IP security. (Cross-listed with ECEN 484)

ECEN 885 SPREAD SPECTRUM COMMUNICATIONS (3 credits)

Introduction to the theory of spread spectrum communications: direct sequence, frequency and time hopping techniques. Topics include properties of pseudo-random binary sequences, low-probability-of-intercept (LPI) and anti-jamming (AJ) methods, performance of spread spectrum systems, applications of spread spectrum techniques in radio frequency and optical code-division multiple access (CDMA) systems.
Prerequisite(s): ECEN 463 or ECEN 861 or permission.

ECEN 886 APPLIED PHOTONICS (3 credits)

Introduction to the use of electromagnetic radiation for performing optical measurements in engineering applications. Basic electromagnetic theory and light interaction with matter are covered with corresponding laboratory experiments conducted. (Cross-listed with ECEN 486)
Prerequisite(s): ECEN 306 or permission. Not open to non-degree graduate students.

ECEN 888 WIRELESS SECURITY (4 credits)

A comprehensive overview on the recent advances in wireless network and system security. Covers security issues and solutions in emerging wireless access networks and systems as well as multihop wireless networks. (Cross-listed with ECEN 488)
Prerequisite(s): ECEN 325

ECEN 891 SPECIAL TOPICS IN ELECTRIC AND COMPUTER ENGINEERING IV (1-4 credits)

Special topics in the emerging areas of electrical, computer and electronics engineering which may not be covered in the other courses in the electrical, and computer engineering curriculum. (Cross-listed with ECEN 491)

ECEN 892 INDIVIDUAL STUDY IN ELECTRICAL AND COMPUTER ENGINEERING IV (1-3 credits)

Individual study in a selected electrical, computer or electronics engineering area under the supervision and guidance of a Electrical and Computer Engineering faculty member. (Cross-listed with ECEN 492).

ECEN 893 INDEPENDENT STUDY IN COMPUTER AND ELECTRONICS ENGINEERING (1-3 credits)

Individual study at the graduate level in a selected computer or electronics engineering area under the supervision and guidance of a Computer and Electronics Engineering faculty member.
Prerequisite(s): Departmentally approved proposal.

ECEN 895 SPECIAL TOPICS (1-3 credits)

Special topics in the newly emerging areas of computer and electronics engineering not covered in the other courses in the computer and electronics engineering curriculum.

ECEN 898 SPECIAL TOPICS IN ELECTRICAL ENGINEERING IV (1-6 credits)

Offered as the need arises to meet electrical engineering topics for fourth-year and graduate students not covered in other courses. (Cross-listed with ECEN 498)

ECEN 899 MASTERS THESIS (1-10 credits)

Masters thesis work.
Prerequisite(s): Admission to masters degree program and permission of supervisory committee chair. Not open to non-degree graduate students.

ECEN 911 COMMUNICATION THEORY (3 credits)
Applications of probability and statistics to signals and noise; correlation; sampling; shot noise; spectral analysis; Gaussian processes; filtering.
Prerequisite(s): ECEN 862, and ECEN 864 or ECEN 810.

ECEN 912 ERROR CONTROL CODING (3 credits)
Fundamentals of error correction and detection in digital communication and storage systems. Linear and algebraic block codes; Hamming, BCH and Reed Solomon codes; algebraic decoding techniques; structure and performance of convolutional codes, turbo codes, and trellis coded modulation; MAP, Viterbi, and sequential decoding techniques.
Prerequisite(s): ECEN 410 or ECEN 810, and ECEN 464 or ECEN 864, or Permission.

ECEN 913 ADVANCED ANALOG AND MIXED-SIGNAL INTEGRATED CIRCUITS (3 credits)
Advanced current mirrors and op-amps. Comparators and sample/hold (S/H) circuits. Band-gap reference circuits. Trans-linear circuits and analog multipliers. Voltage controlled oscillators. Operational trans-conductance amplifiers (OTA's). Switched capacitor circuits. Data converters. Non-linearity, mismatch ,and short-channel effects. Continuous time domain integrated filters. Current conveyors. Phase locked loops. Analog CAD.
Prerequisite(s): ECEN 869 and permission. Not open to non-degree graduate students.

ECEN 915 ADAPTIVE SIGNAL PROCESSING (3 credits)
Adaptive filtering algorithms, frequency and transform domain adaptive filters, and simulation and critical evaluation of adaptive signal processing for real world applications.
Prerequisite(s): ECEN 410 or ECEN 810, ECEN 463 or ECEN 863, and permission. Not open to non-degree graduate students.

ECEN 926 STATISTICAL SIGNAL PROCESSING FOR WIRELESS COMMUNICATION (3 credits)
Statistical signal processing and applications for wireless communications covering the characterics of random signals, optimum linear filters, statistical parameter estimation using maximum likeihood (ML) and minimum mean-square error (MMSE) methods, adaptive signal processing using least-mean-square (LMS) and recursive least-square (RLS) approaches, Kalman filtering, and eigenanalysis algorithms. Applications of the statistical signal processing techniques in wireless communications will be explored.
Prerequisite(s): ECEN 424 or ECEN 824, ECEN 476 or ECEN 876, and ECEN 883. Not open to non-degree graduate students.

ECEN 932 ADVANCED POWER ELECTRONICS AND APPLICATIONS (3 credits)
Analysis and design of power electronic circuits and their applications, including: snubber circuits, resonant converters and soft switching techniques, pulse-width modulation techniques, control of power electronic circuits, power electronics and control for electric machines and wind energy systems, flexible AC-transmission system (FACTS) devices, and high-voltage DC (HVDC) transmission.
Prerequisite(s): ECEN 436 or ECEN 836, ECEN 428 or ECEN 828.

ECEN 935 COMPUTATIONAL INTELLIGENCE (3 credits)
Computational intelligence paradigms and their applications, including: artificial neural networks, fuzzy logic systems, swarm intelligence, evolutionary computation (e.g. genetic algorithms), machine learning (e.g., supervised learning, unsupervised learning, and reinforcement learning), neurocontrol and adaptive critic designs, and applications of computational intelligence for system identification, state estimation, time series prediction, signal processing, adaptive control, optimization, diagnostics, prognostics, etc.
Prerequisite(s): MATH 1970, MATH 2350 and MATH 2050. Good skills using MATLAB. Not open to non-degree graduate students.

ECEN 946 OPTIMAL FILTERING ESTIMATION AND PREDICTION (3 credits)
Techniques for optimally extracting information about the past, present, or future status of a dynamic system from noise-corrupted measurements on that system.
Prerequisite(s): ECEN 810 or permission. Not open to non-degree graduate students.

ECEN 957 ADVANCED COMPUTER METHODS IN POWER SYSTEM ANALYSIS (3 credits)
Power System matrices, sparsity techniques, network equivalents, contingency analysis, power flow optimization, state estimation, and power system restructuring examined via computer methods.
Prerequisite(s): ECEN 806. Not open to non-degree graduate students.

ECEN 959 WIRELESS COMMUNICATIONS (3 credits)
Principles of wireless communications, including: description of the wireless channel characteristics; ultimate performance limits of wireless systems; performance analysis of digital modulation techniques over wireless channels; diversity techniques; adaptive modulation; multiple-antenna communications; multi-carrier modulation; and multi-user wireless communications.
Prerequisite(s): ECEN 864 and permission. Not open to non-degree graduate students.

ECEN 960 SOLID STATE DEVICES (3 credits)
Gallium arsenide and silicon devices. Device properties based on structure and physical properties of the materials.
Prerequisite(s): ECEN 315, not open to non-degree graduate students.

ECEN 965 PASSIVE MICROWAVE COMPONENTS (3 credits)
Application of Maxwell's Equations to the analysis of waveguides, resonant cavities, filters and other passive microwave devices.
Prerequisite(s): ECEN 867 or ECEN 868. Not open to non-degree graduate students.

ECEN 967 INTRODUCTION TO QUANTUM ELECTRONICS (3 credits)
Introduction to the quantum aspects of electron devices.
Prerequisite(s): Not open to non-degree graduate students.

ECEN 971 SEMINAR (1-12 credits)
Selected topics.
Prerequisite(s): Permission. Not open to non-degree graduate students.

ECEN 975 OPTICAL PROPERTIES OF MATERIALS (3 credits)
Quantum mechanical description of the optical properties of solids (complex refractive index and its dispersion, effects of electric and magnetic fields, temperature, stress; additional special topics as desired.
Prerequisite(s): ECEN 967 or permission. Not open to non-degree graduate students.

ECEN 977 SPACE-TIME WIRELESS COMMUNICATIONS (3 credits)
Theory of space-time (ST) wireless communication systems. Emphasis will be placed on spatial diversity, smart antenna systems, MIMO capacity of multi-antenna fading channels, space-time signaling, space-time receivers and interference mitigation. Includes overview of more advanced topics such as MIMO-OFDM and current trends in research and industry.
Prerequisite(s): ECEN 461, ECEN 463, ECEN 476.

ECEN 979 NON-LINEAR FIBER OPTIC SYSTEMS (3 credits)
Linear and non-linear propagations in optical fibers. Topics include fiber non-linearity, fundamentals of optical amplifiers, semiconductor and fiber amplifiers, soliton communications. Applications include high capacity and long distance transmissions, all-optical networks.
Prerequisite(s): ECEN 479 or ECEN 879 or permission.

ECEN 986 OPTOELECTRONICS (3 credits)
Modern phenomena associated with optoelectronics Electo-optical effect such as Pocket effect, Kerr effect, and nonlinear optical phenomena. Material and devices used in modern communications, femtosecond lasers, and optical computer systems.
Prerequisite(s): ECEN 886. Not open to non-degree graduate students.

ECEN 991 INDEPENDENT STUDY (1-24 credits)
Selected topic under the direction and guidance of a faculty member.
Prerequisite(s): Permission. Not open to non-degree graduate students.

ECEN 992 RESEARCH OTHER THAN THESIS (1-6 credits)
Supervised non-thesis research and independent study.
Prerequisite(s): Permission and graduate standing.

ECEN 996 TOPICS IN ELECTRICAL ENGINEERING (3 credits)
Selected topics in electrical engineering.
Prerequisite(s): Permission. Not open to non-degree graduate students.

ECEN 998 ADVANCED SPECIAL TOPICS (1-3 credits)
Advanced topics in computer and electronics engineering not covered in
other 9000 level courses.
Prerequisite(s): Permission.

ECEN 999 DOCTORAL DISSERTATION (1-24 credits)
Dissertation research.
Prerequisite(s): Admission to doctoral degree program and permission of
supervisory committee chair. Not open to non-degree graduate students.

**ECEN 8226 INTRODUCTION TO PHYSICS AND CHEMISTRY OF
SOLIDS (3 credits)**
Introduction to structural, thermal, electrical, and magnetic properties
of solids, based on concepts of atomic structure, chemical bonding in
molecules, and electron states in solid state devices. (Cross-listed with
ECEN 4220).
Prerequisite(s): Not open to non-degree graduate students.