

ELECTRICAL & COMPUTER ENGINEERING

The mission of the department of Electrical & Computer Engineering (ECE) at the University of Nebraska is to provide undergraduate and graduate level education in electrical and computer engineering, perform research and other scholarly activities, and furnish service to the state, nation, industry, and the profession. To fulfill this mission, the ECE department offers the degrees of Bachelor of Science in Electrical Engineering and in Computer Engineering, as well as several graduate programs. The faculty takes pride in its high level of interaction with both undergraduate and graduate students.

General Requirements

The following sections apply to the electrical engineering and computer engineering programs. For more details visit the ECE department's website (<https://engineering.unl.edu/ece/>)

Advisement

Upon entry into the curriculum, each student will be assigned an academic advisor. It is required that each student meet with the advisor prior to each class registration period and that all courses to be applied toward the degree be selected with the advice and approval of the advisor.

The student is expected to have his/her academic records reviewed and approval obtained from the ECE department prior to application to the University registrar for awarding of a degree in order to ensure that all curricular requirements have been satisfied by the time of the student's intended graduation.

Curriculum

Because of the rapid developments in the fields of electrical and computer engineering, the curricular requirements are continually reviewed and updated to reflect technological advances. Curricular sequence and course descriptions contained herein are intended to serve as general guidelines. Contact the ECE department for information on any changes to the requirements that are currently in effect but not listed in this catalog.

Students who do not maintain continuous progress toward a degree through enrollment in applicable course work will be considered as new students upon reentering the electrical or computer engineering curricular sequence and will be subject to the requirements of the curriculum current at the time of their reentry. Certain courses may not be valid as prerequisites or as credit toward the degree after two academic years; the student's academic advisor should be consulted regarding applicability. The applicable University catalogs and college academic policies must be followed to ensure the student satisfies all of the Achievement Centered Education (ACE) requirements.

Special Interest Areas

Opportunities are provided for the development of areas of special interest through enrollment in the individual study courses which are offered at the freshman through senior level for the student who may wish to develop a topic under the guidance of a department faculty member. Enrollment is by permission after a written proposal has been approved. Special topics courses are also offered by the department as the need arises. Academic advisers should be consulted regarding the particular topics to be covered and the necessary prerequisites for each offering of this course. Students who expect to continue their education at the graduate level after the award of the baccalaureate degree should consult their advisors regarding course selections that would enhance that objective.

Students are encouraged to develop their professional and leadership potential through participation in student chapters of related professional organizations and in University extracurricular activities. Participation in the University Honors Program is encouraged for those who qualify.

Transfer Course Work

The applicability of transfer course work with engineering content toward credit in the curriculum is determined on a case-by-case basis by the department.

Financial Aid

Numerous opportunities exist for students to obtain financial aid during the course of their academic work at the university. The office of the dean of the college and the campus financial aid office should be consulted to determine the availability of such assistance.

Degrees Offered

- Electrical Engineering (<http://catalog.unomaha.edu/undergraduate/college-engineering/electrical-computer-engineering/electrical-engineering-bs/>)
- Computer Engineering (<http://catalog.unomaha.edu/undergraduate/college-engineering/electrical-computer-engineering/computer-engineering-bs/>)

ECEN 103 ELECTRICAL AND COMPUTER ENGINEERING FUNDAMENTALS (4 credits)

Introduction to DC circuit analysis and digital logic. Topics include Ohm's and Kirchoff's laws, mesh and nodal analysis, Boolean algebra, logic gates, minimization, counters and flip-flops. Uses of computer based resources for data analysis and report generation. Use of internet to locate and retrieve engineering resources.

Prerequisite(s): MATH 1950 (pre or coreq)

ECEN 106 MICROPROCESSOR APPLICATIONS (3 credits)

Introduction to assembly language programming of microprocessors/microcontrollers, assemblers, and debugging tool utilization. Microprocessor system hardware components, control signals, and 'C' language micro-controller programming.

Prerequisite(s): ECEN 103, CIST 1400

ECEN 123 INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING (1 credit)

Laboratory design projects introducing some basic concepts and skills needed in electrical and computer engineering.

Prerequisite(s): Coreq: CIST 1400. Open to first year students only or by permission.

ECEN 192 INDIVIDUAL STUDY IN COMPUTER AND ELECTRONICS ENGINEERING I (1-3 credits)

Individual study at the freshman level in a selected electrical, computer, or electronics engineering area under the supervision and guidance of an electrical and computer engineering faculty member.

Prerequisite(s): Departmentally approved proposal

ECEN 194 SPECIAL TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING I (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.

Prerequisite(s): Freshman standing or permission.

ECEN 198 SPECIAL TOPICS IN ELECTRICAL ENGINEERING I (1-6 credits)

Offered as the need arises to treat electrical engineering topics for first-year students not covered in other courses.

Prerequisite(s): Permission. Not open to non-degree graduate students.

ECEN 211 ELEMENTS OF ELECTRICAL ENGINEERING (3 credits)

Basic circuit analysis including direct and alternating currents and operational amplifiers. Digital signals and circuits. Not for electrical engineering majors.

Prerequisite(s): MATH 1960 and PHYS 2110

ECEN 213 ELECTRICAL CIRCUITS I (3 credits)

Electrical circuit theory, Kirchoff's and Ohm's laws, circuit analysis theorems, Norton and Thevenin equivalence. The analysis of resistor circuits, with capacitors and inductors, in DC and AC steady state. Transients and variable frequency response are studied, including computer solutions to circuit problems.

Prerequisite(s): ECEN 103 and ECEN 225. MATH 2350 prior to or concurrent.

ECEN 214 ELECTRICAL CIRCUITS II (3 credits)

Introduction to the analysis of electrical circuits in sinusoidal steady states. The concepts of impedance, phasors, power, frequency response, resonance, magnetic circuits and two-part networks. Transform techniques for circuit analysis.

Prerequisite(s): ECEN 213 and ECEN 218. Pre or Corequisite: MATH 2050.

ECEN 215 ELECTRONICS AND CIRCUITS I (3 credits)

Introduction to electrical engineering circuit theory. Kirchoff's law and circuit analysis theorem applied to steady state DC resistive circuits. Analysis of transient RLC and sinusoidal steady-state circuits. Modern computer methods are employed.

Prerequisite(s): Co-Req; MATH 1970

ECEN 216 ELECTRONICS AND CIRCUITS II (3 credits)

Steady-state power calculations for sinusoidal single-phase and balanced three-phase circuits. Mutual inductance. Frequency response. Introduction to the fundamentals of semiconductor theory and their applications to P-N junction devices. Kirchoff's laws and circuit analysis theorems applied to steady-state diode circuits. Modern computer methods employed.

Prerequisite(s): ECEN 215 with grade of C or higher. Coreq: MATH 2350.

ECEN 217 ELECTRICAL CIRCUITS III (1 credit)

Analysis of first and second order RLC circuits using differential equations and Laplace transforms. Variable frequency network performance analysis. This course is for computer engineering majors only.

Prerequisite(s): ECEN 213. Not open to non-degree graduate students.

ECEN 218 ELECTRICAL CIRCUITS LABORATORY I (1 credit)

The use of laboratory tools for measurement and verification of electrical concepts. Experiments using both passive and semiconductor devices at audio frequencies. Analysis verification with computer simulation.

Prerequisite(s): Coreq: ECEN 213.

ECEN 220 INTRODUCTION TO EMBEDDED SYSTEMS (3 credits)

Basic hardware and software concepts of embedded microprocessor systems and interfacing with other hardware components. Simple circuits are designed and drivers to run these circuits are written. Design and build hardware and write drivers in assembly language.

Prerequisite(s): CSCI 1200 or working knowledge of C programming. Not open to non-degree graduate students.

ECEN 222 ELECTRONIC CIRCUITS I (4 credits)

Analysis and design of modern electronic circuits. Diode circuits, bipolar and field effect transistor switching and amplifier circuits, and operational amplifier circuits.

Prerequisite(s): ECEN 213 with grade of C or better, and ECEN 218.

ECEN 224 INTRODUCTION TO SIGNAL PROCESSING (4 credits)

This course demonstrates the use of mathematical and digital computation tools key to engineering applications. Auditory and visual senses are used in the presentation and study of sinusoidal signals, sampling, frequency response and filtering theory.

Prerequisite(s): ECEN 106, CIST 1400, MATH 1960.

ECEN 225 ELECTRICAL AND COMPUTER ENGINEERING SEMINAR (1 credit)

An overview of electrical, computer, electronics and telecommunication fields. There will be information on professional careers available upon graduation. Professionalism and ethics are addressed as well as the need for lifelong learning experiences.

Prerequisite(s): ECEN 103 or parallel

ECEN 231 ELECTRICAL ENGINEERING LABORATORY (1 credit)

Laboratory accompanying ECEN 211.

Prerequisite(s): Coreq: ECEN 211. Not open to non-degree graduate students.

ECEN 235 INTRODUCTORY ELECTRICAL LABORATORY I (1 credit)

Laboratory accompanying ECEN 215.

Prerequisite(s): Coreq: ECEN 215.

ECEN 236 INTRODUCTORY ELECTRICAL LABORATORY II (1 credit)

Laboratory accompanying ECEN 216

Prerequisite(s): ECEN 235, Coreq: ECEN 216.

ECEN 292 INDIVIDUAL STUDY IN ELECTRICAL AND COMPUTER ENGINEERING II (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.

Prerequisite(s): Sophomore Standing, ECE departmentally approved proposal.

ECEN 294 SPECIAL TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING II (1-4 credits)

Special topics in the emerging areas of electrical, computer and electronics engineering at the sophomore level which may not be covered in the other courses in the electrical and engineering curriculum.

Prerequisite(s): Sophomore standing or permission.

ECEN 304 SIGNALS AND SYSTEMS I (3 credits)

Mathematical modeling of physical systems and signals. Representation of signals in terms of basic functions. Fourier Series expansion, Fourier Transforms, Laplace and Z-Transforms. Input-output relations, convolution. Transfer functions. System Stability. Poles/zeros and s- and z-plane methods. Applications.

Prerequisite(s): ECEN 214 or ECEN 216 with a grade of C or better and MATH 2350.

ECEN 305 PROBABILITY THEORY AND STATISTICS FOR ELECTRICAL AND COMPUTER ENGINEERS (3 credits)

Random experiment model, random variables, functions of random variables, and introduction to random processes; statistics and practical data analysis.

Prerequisite(s): MATH 1970/(UNL)MATH 208

ECEN 306 ELECTROMAGNETIC FIELD THEORY (3 credits)

Complex vectors, Maxwell's equations. Uniform plane waves. Wave reflection and transmission at interfaces. Waveguides and resonators. Transmission line principles. Antennas. Topics in waves.

Prerequisite(s): ECEN 215 or ECEN 213 with grade of C or better, PHYS 2120, MATH 1970, MATH 2350., not open to non-degree graduate students.

ECEN 307 ELECTRICAL ENGINEERING LABORATORY I (2 credits)

Laboratory work on circuits and systems, digital and analog electronic circuits.

Prerequisite(s): ECEN 106; ECEN 222 or ECEN 236; Coreq: ECEN 313 or ECEN 370; Admission to College of Engineering; not open to non-degree graduate students.

ECEN 310 DIGITAL DESIGN AND INTERFACING (4 credits)

Digital design from both the circuit and system perspectives. Topics include the structure and analysis of digital integrated circuits, interface signal integrity, Field Programmable Gate Array (FPGA) design and synthesis, software simulation. Lab exercises provide hands-on experience with design tools and the design process.

Prerequisite(s): ECEN 222. Prereq or coreq: ECEN 313.

ECEN 313 SWITCHING CIRCUITS THEORY (4 credits)

Combinational circuit analysis and design. State machine analysis and design. Includes synchronous/clock mode circuits and asynchronous sequential circuits. Minimization, race and hazard elimination are covered. Circuits are implemented in discrete logic and in CPLD and FPGA devices. VHDL hardware description language is used to describe circuits. Circuits are implemented in discrete logic and in CPLD/FPGA devices.

Prerequisite(s): ECEN 106.

ECEN 316 ELECTRONICS AND CIRCUITS III (3 credits)

Kirchhoff's laws and circuit analysis theorems applied to steady state transistor circuits. Frequency response of filters and amplifiers. Basic power amplifier types. Advanced operational amplifier circuits. Introduction to the fundamentals of semiconductor theory and their application to p-n junction and field devices.

Prerequisite(s): ECEN 216 with grade of C or better.

ECEN 317 ELECTRICAL ENGINEERING LABORATORY II (2 credits)

Lab work on electromagnetic fields and waves, solid state devices, discrete systems, control systems, and communications.

Prerequisite(s): ECEN 304, ECEN 307 Coreq: ECEN 306, ECEN 316, not open to non-degree graduate students.

ECEN 325 COMMUNICATIONS SYSTEMS (4 credits)

Relevant communication systems; principles of transmission and reception; amplitude; frequency and phase modulation. Sampling theorem, pulse-code modulation and delta modulation.

Prerequisite(s): ECEN 222; Coreq: ECEN 305.

ECEN 327 DISCRETE SYSTEMS LABORATORY (1 credit)

Laboratory work on discrete systems.

Prerequisite(s): ECEN 106 or ECEN 220 and ECEN 307

ECEN 328 APPLIED FIELDS AND LINES I (3 credits)

Transmission lines. Discontinuities, different termination, and matching methods. Application of vector analysis to Maxwell's equations. Uniform plane waves including reflection/transmission. S-parameters. Principles of antennas. LW, MW, SW, USW propagation.

Prerequisite(s): MATH 1970 and MATH 2350

ECEN 329 APPLIED FIELDS AND LINES II (3 credits)

Metallic waveguides with rectangular, circular and coaxial cross section, antennas, free space, propagation in free space, applications.

Prerequisite(s): ECEN 328.

ECEN 332 ASSEMBLY LANGUAGE PROGRAMMING (1 credit)

Architecture and assembly language programming of 8-bit and 32-bit microcontrollers.

Prerequisite(s): ECEN 106

ECEN 338 INTRODUCTION TO POWER AND ENERGY SYSTEMS (3 credits)

Energy sources, environmental impacts, power systems principles, three phase circuits, transmission lines, transformers, per unit analysis, generators, loads, and power system modeling.

Prerequisite(s): ECEN 216 or ECEN 214 with grade of C or better. Not open to non-degree graduate students.

ECEN 345 MOBILE ROBOTICS I (4 credits)

Introduction to the primary issues spanning the field of mobile robotics, including robotics history, robot components (sensors, actuators), robot system design considerations, low-level control (feedback control) and robotics control architectures. The lab focuses on the practical implementation of autonomous robot control on a real mobile robot using behavior-based methods in the C language.

Prerequisite(s): ECEN 106, ECEN 213.

ECEN 347 ELECTRICAL ENGINEERING LABORATORY II (1 credit)

Lab work on electromagnetics, fields and waves, solid state devices and control systems.

ECEN 350 ELECTRICAL AND COMPUTER ENGINEERING COOPERATIVE EDUCATIONAL EXPERIENCE (1-3 credits)

For cooperatives primarily technical in nature lasting 4.5 months or greater. Weekly communication and/or final report required. Must be taken during or after the semester in which the Co-op occurs.

Prerequisite(s): Permission. Not open to non-degree graduate students.

ECEN 352 ELECTRONIC CIRCUITS II (4 credits)

Operational amplifier circuit design and analysis with emphasis on feedback and stability. Design and analysis of large signal power amplifiers. Other integrated devices such as regulators, comparators, Schmitt triggers, oscillators and active filters.

Prerequisite(s): ECEN 222

ECEN 355 SIGNALS AND LINEAR SYSTEMS (3 credits)

Continuous and discrete time representations of signals. System modeling and analysis using differential and difference equations. Fourier, Laplace and z transforms. State description of continuous and discrete time transfer functions. The primary mathematical tools used in the analysis of continuous and discrete time systems.

Prerequisite(s): ECEN 214

ECEN 361 ADVANCED ELECTRONICS AND CIRCUITS (3 credits)

Analog and digital electronics for discrete and integrated circuits. Multistage amplifiers, frequency response, feedback amplifiers, simple filters and amplifiers MOS and bipolar logic gates and families A/D and D/A converters.

Prerequisite(s): ECEN 316; not open to non-degree graduate students.

ECEN 362 DATA AND TELECOMMUNICATIONS TRANSCEIVERS (4 credits)

Noise and signal distortions in communication systems, impedance matching techniques, high frequency measurement techniques, design of high frequency amplifiers and oscillators, PLL and frequency synthesizers, data synchronization and multiplexing techniques, Antennas and their arrays.

Prerequisite(s): ECEN 352; Pre or Coreq.: ECEN 325, ECEN 328

ECEN 370 DIGITAL LOGIC DESIGN (3 credits)

Combinational and sequential logic circuits. MSI chips, programmable logic devices (PAL, ROM, PLA) used to design combinational and sequential circuits. CAD tools. LSI and PLD components and their use. Hardware design experience.

Prerequisite(s): ECEN 121, not open to non-degree graduate students.

ECEN 392 INDIVIDUAL STUDY IN ELECTRICAL AND COMPUTER ENGINEERING III (1-3 credits)

Individual study in a selected electrical, computer or electronics engineering area under the supervision and guidance of a electric and computer engineering faculty member.

Prerequisite(s): Junior standing and ECE departmentally approved proposal.

ECEN 394 SPECIAL TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING III (1-4 credits)

Special topics in the emerging areas in electrical, computer and electronics engineering which may not be covered in the other courses in the Electrical and Computer engineering curriculum.

Prerequisite(s): Junior standing or permission.

ECEN 398 SPECIAL TOPICS ELECTRICAL ENGINEERING III (1-6 credits)

Offered as the need arises to treat electrical engineering topics for third-year students not covered in other courses.

Prerequisite(s): Permission. Not open to nondegree students.

ECEN 399 UNDERGRADUATE RESEARCH (1-3 credits)

Research accompanied by a written report.

Prerequisite(s): Electrical engineering seniors or permission., not open to non-degree graduate students

ECEN 400 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 800)

Prerequisite(s): Senior Standing in Engineering or Permission. Not open to non-degree graduate students.

ECEN 406 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 806)

Prerequisite(s): ECEN 338, not open to non-degree graduate students.

ECEN 407 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 807)

Prerequisite(s): ECEN 305, not open to non-degree graduate students.

ECEN 408 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 808)

Prerequisite(s): ECEN 306, not open to non-degree graduate students.

ECEN 410 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 810)

Prerequisite(s): ECEN 305. Not open to non-degree graduate students.

ECEN 416 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 816)

Prerequisite(s): PHYS 2120, not open to non-degree graduate students.

ECEN 417 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 817)

Prerequisite(s): ECEN 421 or ECEN 821. Not open to non-degree graduate students.

ECEN 420 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 820)

Prerequisite(s): Senior or graduate standing. Not open to non-degree graduate students.

ECEN 421 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 821)

Prerequisite(s): PHYS 2130. Not open to non-degree graduate students.

ECEN 424 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 824)

Prerequisite(s): ECEN 355

ECEN 428 POWER ELECTRONICS (3 credits)

Basic analysis and design of solid-state power electronic devices and converter circuitry. (Cross-listed with ECEN 828)

Prerequisite(s): ECEN 304, ECEN 316.

ECEN 430 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 830)

Prerequisite(s): Senior standing or permission.

ECEN 433 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 833)

Prerequisite(s): ECEN 310 with grade of C or better and ECEN 332 with grade of C or better.

ECEN 435 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 835)

Prerequisite(s): ECEN 433/ECEN 833 with grade of C or better, STAT 3800.

ECEN 436 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 836).

Prerequisite(s): PHYS 2120 and ECEN 216

ECEN 437 PARALLEL AND DISTRIBUTED PROCESS (3 credits)

Parallel and Distributed Processing concepts, principles, techniques and machines. (Cross-listed with ECEN 837).

Prerequisite(s): ECEN 435 or ECEN 835

ECEN 442 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 842)

Prerequisite(s): MATH 2350. Not open to non-degree graduate students.

ECEN 444 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 844)

Prerequisite(s): ECEN 304. Not open to non-degree graduate students.

ECEN 448 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 848)

Prerequisite(s): ECEN 305 or STAT 3800.

ECEN 450 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 850)

Prerequisite(s): Computer programming language and ECEN 305 or STAT 3800 or equivalent.

ECEN 451 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 851).

Prerequisite(s): ECEN 310

ECEN 452 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 852)

Prerequisite(s): ECEN 310

ECEN 453 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 853).

Prerequisite(s): By permission.

ECEN 454 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 854)

Prerequisite(s): ECEN 338 or ECEN 838. Not open to non-degree graduate students.

ECEN 460 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 860)

Prerequisite(s): Prior programming experience.

ECEN 461 DIGITAL COMMUNICATIONS MEDIA (4 credits)

Topics related to the transport of bit streams from one geographical location to another over various physical media such as wire pairs, coaxial cable, optical fiber, and radio waves. Transmission characteristics, media interfacing, delay, distortion, noise, and error detection and correction techniques. (Cross-listed with ECEN 861)

Prerequisite(s): ECEN 325 or ECEN 462

ECEN 462 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 862)

Prerequisite(s): ECEN 304 and ECEN 305. Not open to non-degree graduate students.

ECEN 463 DIGITAL SIGNAL PROCESSING (3 credits)

Discrete system analysis using Z-transforms. Analysis and design of digital filters. Discrete Fourier transforms. (Cross-listed with ECEN 863)

Prerequisite(s): ECEN 304. Not open to non-degree graduate students.

ECEN 464 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 864)

Prerequisite(s): ECEN 462. Not open to non-degree graduate students.

ECEN 465 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 865)

Prerequisite(s): ECEN 305. Not open to non-degree graduate students.

ECEN 466 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 866)

Prerequisite(s): ECEN 362; ECEN 461/ECEN 861 prior to or concurrent.

ECEN 467 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 867)

Prerequisite(s): ECEN 306. Not open to non-degree graduate students.

ECEN 468 MICROWAVE ENGINEERING (3 credits)

Applications of active and passive devices to microwave systems. Includes impedance matching, resonators, and microwave antennas. (Cross-listed with ECEN 868)

Prerequisite(s): ECEN 306. Not open to non-degree graduate students.

ECEN 469 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 869)

Prerequisite(s): ECEN 361. Not open to non-degree graduate students.

ECEN 470 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 870)

Prerequisite(s): ECEN 361. Not open to non-degree graduate students.

ECEN 471 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 871)

Prerequisite(s): ECEN 325

ECEN 473 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 873)

Prerequisite(s): ECEN 325

ECEN 474 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 874)

Prerequisite(s): ECEN 370. Not open to non-degree graduate students.

ECEN 475 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 875)

Prerequisite(s): ECEN 325

ECEN 476 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 876)

Prerequisite(s): ECEN 325 or ECEN 462 prior to or concurrent

ECEN 477 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 877)

Prerequisite(s): ECEN 474 or ECEN 874. Not open to non-degree graduate students.

ECEN 479 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 879)

Prerequisite(s): ECEN 463.

ECEN 480 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 880)

Prerequisite(s): PHYS 2130

ECEN 482 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 882)

Prerequisite(s): ECEN 328

ECEN 484 NETWORK SECURITY (4 credits)

Network security and cryptographic protocols. Classical encryption 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 884)

Prerequisite(s): ECEN 325

ECEN 486 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 886)

Prerequisite(s): ECEN 306 or permission. Not open to non-degree graduate students.

ECEN 488 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 888)

Prerequisite(s): ECEN 325

ECEN 491 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 891)

Prerequisite(s): Senior standing

ECEN 492 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 892).

Prerequisite(s): Senior or graduate standing and departmentally approved proposal.

ECEN 494 ELECTRICAL ENGINEERING CAPSTONE I (2 credits)

A substantial design project that allows application of electrical engineering skills to a multidisciplinary project. Requires project definition, planning and scheduling, effective written and oral communication of technical ideas, incorporation of realistic constraints and engineering standards, functioning effectively on a multidisciplinary team, and applying new ideas as needed to meet project goals.

Prerequisite(s): ECEN 222, ECEN 304, ECEN 306, ECEN 313, and (UNO) ENGL 1160. The ECE department changed its English composition requirements to ENGL 1160 (UNO); ENGL 1160 is required, not technical writing.

ECEN 495 ELECTRICAL ENGINEERING CAPSTONE II (3 credits)

A substantial design project that allows application of electrical engineering skills to a multidisciplinary project. Requires project definition, planning and scheduling, effective written and oral communication of technical ideas, incorporation of realistic constraints and engineering standards, functioning effectively on a multidisciplinary team and applying new ideas as needed to meet project goals.

Prerequisite(s): ECEN 494

ECEN 496 COMPUTER ENGINEERING CAPSTONE I (2 credits)

A substantial design project that allows application of computer engineering skills to a multidisciplinary project. Requires project definition, planning and scheduling, effective written and oral communication of technical ideas, incorporation of realistic constraints and engineering standards, functioning effectively on a multidisciplinary team, and applying new ideas as needed to meet project goals. The first in a two semester computer engineering capstone senior design course sequence.

Prerequisite(s): ECEN 433; (UNO) ENGL 1160. The ECE department changed its English composition requirements to ENGL 1160 (UNO); ENGL 1160 is required, not technical writing.

ECEN 498 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 898)

Prerequisite(s): Permission.

ECEN 499 COMPUTER ENGINEERING CAPSTONE II (3 credits)

Requires the completion of a design project that demonstrates the ability to combine knowledge from individual courses in the program to complete a design task. The capstone design course for the B.S. in computer engineering, electrical engineering and electronics engineering.

Prerequisite(s): ECEN 496. Not open to non-degree graduate students.

ECEN 4220 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 8226).

Prerequisite(s): PHYS 2130 or CHEM 3350, MATH 2350 or permission. Not open to non-degree graduate students.