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, computer, and electronics 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 award 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 upgraded 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, computer, or electronics 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 1030 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)/Corequisite(s): MATH1950 (pre or coreq)

ECEN 1060 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)/Corequisite(s): ECEN1030, CIST1400

ECEN 1210 INTRODUCTION TO ELECTRICAL ENGINEERING I (2 credits)
An overview of the electrical engineering field. Introduction to some basic concepts and skills needed in electrical engineering. Professionalism and ethics are addressed as well as the need for lifelong learning experiences. Information on professional careers available upon graduation.
Prerequisite(s)/Corequisite(s): Prereq: Open to first year students only or by permission.

ECEN 1220 INTRODUCTION TO ELECTRICAL ENGINEERING II (3 credits)
Introduction to several electrical engineering areas including digital, circuits, electromagnetics, materials and devices, and optics.

ECEN 1234 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)/Corequisite(s): Coreq: CIST 1400. Open to first year students only or by permission.

ECEN 1920 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)/Corequisite(s): Departmentally approved proposal
ECEN 1030 or parallel

ECEN 1060, CIST 1400, MATH 1960.

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

ECEN 1980 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)/Corequisite(s): Permission. Not open to non-degree graduate students.

ECEN 2100 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)/Corequisite(s): MATH1960 and PHYS2110

ECEN 2130 ELECTRICAL CIRCUITS I (3 credits)
Electrical circuit theory, Kirchhoff’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)/Corequisite(s): ECEN 1030 and ECEN 2250. MATH 2350 prior to or concurrent.

ECEN 2140 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)/Corequisite(s): ECEN 2130 and ECEN 2184. Pre or Corequisite: MATH 2050.

ECEN 2150 ELECTRONICS AND CIRCUITS I (3 credits)
Introduction to electrical engineering circuit theory. Kirchhoff'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)/Corequisite(s): Co-Req: MATH 1970

ECEN 2160 ELECTRONICS AND CIRCUITS II (3 credits)

Prerequisite(s)/Corequisite(s): ECEN 2150 with grade of C or higher. Coreq: MATH 2350.

ECEN 2170 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)/Corequisite(s): ECEN 2130. Not open to non-degree graduate students.

ECEN 2184 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)/Corequisite(s): Coreq: ECEN 2130.

ECEN 2200 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)/Corequisite(s): CSCE 155E or working knowledge of C programming. Not open to non-degree graduate students.

ECEN 2220 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)/Corequisite(s): ECEN 2130 with grade of C or better, and ECEN 2184.

ECEN 2240 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)/Corequisite(s): ECEN 1060, CIST 1400, MATH 1960.

ECEN 2250 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)/Corequisite(s): ECEN 1030 or parallel

ECEN 2260 INTRODUCTORY ELECTRICAL LABORATORY I (1 credit)
Laboratory accompanying ELEC 2110.

Prerequisite(s)/Corequisite(s): Coreq: ECEN 2110, not open to non-degree graduate students.

ECEN 2270 SPECIAL TOPICS 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)/Corequisite(s): Sophomore Standing, ECE departmentally approved proposal.

ECEN 2290 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)/Corequisite(s): Sophomore standing or permission.

ECEN 3040 SIGNALS AND SYSTEMS I (3 credits)

Prerequisite(s)/Corequisite(s): ECEN 2140 or ECEN 2160 with a grade of C or better and MATH 2350.

ECEN 3050 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)/Corequisite(s): ECEN 3040

ECEN 3060 ELECTROMAGNETIC FIELD THEORY (3 credits)

Prerequisite(s)/Corequisite(s): ECEN 2150 or ECEN 2130 with grade of C or better, PHYS 2120, MATH 1970, MATH 2350, not open to non-degree graduate students.
ECEN 3074 ELECTRICAL ENGINEERING LABORATORY I (2 credits)
Laboratory work on circuits and systems, digital and analog electronic circuits. 
Prerequisite(s)/Corequisite(s): ECEN 1060; ECEN 2220 or ECEN 2360; Coreq: ECEN 3130 or ECEN 3700; Admission to College of Engineering; not open to non-degree graduate students.

ECEN 3100 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)/Corequisite(s): ECEN 2220. Prereq or coreq: ECEN 3130.

ECEN 3130 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)/Corequisite(s): ECEN 1060.

ECEN 3160 ELECTRONICS AND CIRCUITS II (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)/Corequisite(s): ECEN 2160 with grade of C or better.

ECEN 3174 ELECTRICAL ENGINEERING LABORATORY II (2 credits)
Lab work on electromagnetic fields and waves, solid state devices, discrete systems, control systems, and communications. 
Prerequisite(s)/Corequisite(s): ECEN 3040, ECEN 3074 Coreq: ECEN 3060, ECEN 3160, not open to non-degree graduate students.

ECEN 3250 COMMUNICATIONS SYSTEMS (4 credits)
Relevant communication systems; principles of transmission and reception; modulation and demodulation; frequency and phase modulation. Sampling theorem, pulse-code modulation and delta modulation. 
Prerequisite(s)/Corequisite(s): ECEN 2220; STAT 3800.

ECEN 3274 DISCRETE SYSTEMS LABORATORY (1 credit)
Laboratory work on discrete systems. 
Prerequisite(s)/Corequisite(s): ECEN 1060 or ECEN 2200 and ECEN 3074.

ECEN 3280 APPLIED FIELDS AND LINES I (3 credits)
Prerequisite(s)/Corequisite(s): MATH1970 and MATH2350

ECEN 3290 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)/Corequisite(s): ECEN 3280.

ECEN 3320 ASSEMBLY LANGUAGE PROGRAMMING (1 credit)
Introduction to the architecture and assembly language programming of 80 x 86 microprocessors, Assemblers and debugging tool utilization. 
Prerequisite(s)/Corequisite(s): ECEN 1060

ECEN 3340 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)/Corequisite(s): ECEN 2160 or ECEN 2140 with grade of C or better. Not open to non-degree graduate students.

ECEN 3450 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)/Corequisite(s): ECEN 1060, ECEN 2130.

ECEN 3474 ELECTRICAL ENGINEERING LABORATORY II (1 credit)
Lab work on electromagnetics, fields and waves, solid state devices and control systems. 

ECEN 3560 DIGITAL LOGIC DESIGN (3 credits)
Combination 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)/Corequisite(s): ECEN 1210, not open to non-degree graduate students.

ECEN 3570 DIGITAL SYSTEMS ENGINEERING II (1-3 credits)
Individual study in a selected electrical, computer or electronics engineering area under the supervision and guidance of a selected faculty member. 
Prerequisite(s)/Corequisite(s): Junior standing and ECE departmentally approved proposal.
ECEN 3940  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)/Corequisite(s): Junior standing or permission.

ECEN 3980  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)/Corequisite(s): Permission. Not open to non-degree graduate students.

ECEN 3990  UNDERGRADUATE RESEARCH (1-3 credits)
Research accompanied by a written report.
Prerequisite(s)/Corequisite(s): Electrical engineering seniors or permission., not open to non-degree graduate students

ECEN 4000  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 8006)
Prerequisite(s)/Corequisite(s): Senior Standing in Engineering or Permission. Not open to non-degree graduate students.

ECEN 4060  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 8066)
Prerequisite(s)/Corequisite(s): ECEN 3380, not open to non-degree graduate students.

ECEN 4070  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 8076)
Prerequisite(s)/Corequisite(s): ECEN 3050, not open to non-degree graduate students.

ECEN 4080  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 8086)
Prerequisite(s)/Corequisite(s): ECEN 3060, not open to non-degree graduate students.

ECEN 4100  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 ELEC 8106)
Prerequisite(s)/Corequisite(s): ECEN 3050. Not open to non-degree graduate students.

ECEN 4160  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 8166)
Prerequisite(s)/Corequisite(s): PHYS 2120, not open to non-degree graduate students.

ECEN 4170  SEMICONDUCTOR FUNDAMENTALS II (3 credits)
Analysis of BJTs and MOSFETs from a first principle materials viewpoint. Statics and dynamic analysis and characterization. Device fabrication processes. (Cross-listed with ECEN 8176)
Prerequisite(s)/Corequisite(s): ECEN 4210 or ECEN 8216. Not open to non-degree graduate students.

ECEN 4200  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 8206)
Prerequisite(s)/Corequisite(s): Senior or graduate standing. Not open to non-degree graduate students.

ECEN 4210  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 8216)
Prerequisite(s)/Corequisite(s): PHYS 2130. Not open to non-degree graduate students.

ECEN 4220  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 multirate digital signal processing techniques. (Cross-listed with ECEN 8224)
Prerequisite(s)/Corequisite(s): ECEN 3550

ECEN 4230  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 8336)
Prerequisite(s)/Corequisite(s): ECEN 3100 with grade of C or better and ECEN 3320 with grade of C or better.

ECEN 4240  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 8366)
Prerequisite(s)/Corequisite(s): PHYS 2120 and ECEN 2160

ECEN 4250  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 8306)
Prerequisite(s)/Corequisite(s): Senior standing or permission.

ECEN 4280  POWER ELECTRONICS (3 credits)
Basic analysis and design of solid-state power electronic devices and converter circuitry. (Cross-listed with ECEN 8286)
Prerequisite(s)/Corequisite(s): ECEN 3040, ECEN 3160.

ECEN 4300  DIGITAL SYSTEM DESIGN (3 credits)
Introduction to computer organization, internal computer architecture, instruction set architecture, design and implementation of computer systems. (Cross-listed with ECEN 8306)
Prerequisite(s)/Corequisite(s): Senior standing or permission.

ECEN 4310  MICROPROCESSOR SYSTEM DESIGN (4 credits)
Microcontroller 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 8336)
Prerequisite(s)/Corequisite(s): ECEN 3100 with grade of C or better and ECEN 3320 with grade of C or better.

ECEN 4320  REAL-TIME OPERATING SYSTEMS (3 credits)
Real-time operating systems; real-time systems development; design and implementation of operating systems. (Cross-listed with ECEN 8320)
Prerequisite(s)/Corequisite(s): ECEN 3320 with grade of C or better and STAT 3800.

ECEN 4330  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 8366)
Prerequisite(s)/Corequisite(s): PHYS 2120 and ECEN 2160

ECEN 4350  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 8356)
Prerequisite(s)/Corequisite(s): ECEN 4330/8336 with grade of C or better, STAT 3800.

ECEN 4360  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 8366)
Prerequisite(s)/Corequisite(s): ECEN 4330/8336 with grade of C or better, STAT 3800.

ECEN 4370  PARALLEL AND DISTRIBUTED PROCESS (3 credits)
Parallel and Distributed Processing concepts, principles, techniques and machines. (Cross-listed with ECEN 8376.)
Prerequisite(s)/Corequisite(s): ECEN 4350 or ECEN 8356
ECEN 4420  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 8426)
Prerequisite(s)/Corequisite(s): MATH 2350. Not open to non-degree graduate students.

ECEN 4440  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 8446)
Prerequisite(s)/Corequisite(s): ECEN 3040. Not open to non-degree graduate students.

ECEN 4480  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 8486)
Prerequisite(s)/Corequisite(s): ECEN 3050 or STAT 3800.

ECEN 4500  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 8506)
Prerequisite(s)/Corequisite(s): Computer programming language and ECEN 3050 or STAT 3800 or equivalent.

ECEN 4510  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 8516)
Prerequisite(s)/Corequisite(s): ECEN 3100

ECEN 4520  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 8526)
Prerequisite(s)/Corequisite(s): ECEN 3100

ECEN 4540  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 8546)
Prerequisite(s)/Corequisite(s): ECEN 3380 or ECEN 8385. Not open to non-degree graduate students.

ECEN 4600  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 8606)
Prerequisite(s)/Corequisite(s): Prior programming experience.

ECEN 4610  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 8616)
Prerequisite(s)/Corequisite(s): ECEN 3250 or ECEN 4620

ECEN 4620  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 8626)
Prerequisite(s)/Corequisite(s): ECEN 3040 and ECEN 3050. Not open to non-degree graduate students.

ECEN 4630  DIGITAL SIGNAL PROCESSING (3 credits)
Discrete system analysis using Z-transforms. Analysis and design of digital filters. Discrete Fourier transforms. (Cross-listed with ECEN 8636)
Prerequisite(s)/Corequisite(s): ECEN 3040. Not open to non-degree graduate students.

ECEN 4640  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 8646)
Prerequisite(s)/Corequisite(s): ECEN 4620. Not open to non-degree graduate students.

ECEN 4650  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 8656)
Prerequisite(s)/Corequisite(s): ECEN 3050. Not open to non-degree graduate students.

ECEN 4660  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 8666)
Prerequisite(s)/Corequisite(s): ECEN 3620; ECEN 4610/8616 prior to or concurrent.

ECEN 4670  ELECTROMAGNETIC THEORY AND APPLICATION (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 8676)
Prerequisite(s)/Corequisite(s): ECEN 3060. Not open to non-degree graduate students.

ECEN 4680  MICROWAVE ENGINEERING (3 credits)
Applications of active and passive devices to microwave systems. Includes impedance matching, resonators, and microwave antennas. (Cross-listed with ECEN 8686)
Prerequisite(s)/Corequisite(s): ECEN 3060. Not open to non-degree graduate students.

ECEN 4690  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 8696)
Prerequisite(s)/Corequisite(s): ECEN 3610. Not open to non-degree graduate students.

ECEN 4700  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 8706)
Prerequisite(s)/Corequisite(s): ECEN 3610. Not open to non-degree graduate students.
ECEN 4710 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 Modes (ATM) networks. (Cross-listed with ECEN 8716)
Prerequisite(s)/Corequisite(s): ECEN 3250

ECEN 4730 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 8746)
Prerequisite(s)/Corequisite(s): ECEN 3250

ECEN 4740 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 8746)
Prerequisite(s)/Corequisite(s): ECEN 3700. Not open to non-degree graduate students.

ECEN 4750 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 8756)
Prerequisite(s)/Corequisite(s): ECEN 3250

ECEN 4760 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 8766)

ECEN 4770 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 8776)
Prerequisite(s)/Corequisite(s): ECEN 4740 or ECEN 8746. Not open to non-degree graduate students.

ECEN 4790 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 CEEN8796)
Prerequisite(s)/Corequisite(s): ECEN 4630.

ECEN 4800 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 8806)
Prerequisite(s)/Corequisite(s): PHYS 2130

ECEN 4820 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 8826)
Prerequisite(s)/Corequisite(s): ECEN 3280

ECEN 4840 NETWORK SECURITY (4 credits)
Network security and cryptographic protocols. Classical encryption techniques, block ciphers and stream ciphers, public-key cryptography, authentications digital signatures, key management and distributions, network vulnerabilities, transport-level security, IP security. (Cross-listed with ECEN 8846)
Prerequisite(s)/Corequisite(s): ECEN 3250

ECEN 4860 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 8866)
Prerequisite(s)/Corequisite(s): ECEN 3060 or permission. Not open to non-degree graduate students.

ECEN 4880 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 8886)
Prerequisite(s)/Corequisite(s): ECEN 3250

ECEN 4910 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 8916)
Prerequisite(s)/Corequisite(s): Senior standing

ECEN 4920 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 8926).
Prerequisite(s)/Corequisite(s): Senior or graduate standing and departmentally approved proposal.

ECEN 4940 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. (The first in a two semester capstone senior design course sequence.)
Prerequisite(s)/Corequisite(s): ECEN 3170 or ECEN 2220 and ECEN 3040 and ECEN 3060 and ECEN 3130; ENGL 3980 or permission; Admission to College of Engineering.

ECEN 4950 CAPSTONE II (3 credits)
The second in a two semester senior design course sequence. Continuation of a substantial design project that allows application of electrical engineering skills to multidisciplinary project. A project that meets specifications and that is completed according to a pre-determined schedule and within budget. Requires effective written and oral communication of technical ideas, incorporation of realistic constraints, engineering standards, functioning effectively on a multidisciplinary team, and applying new ideas as needed to meet project goals.
Prerequisite(s)/Corequisite(s): ECEN 4940 or permission. Not open to non-degree students.

ECEN 4960 CAPSTONE I (2 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 8886)
Prerequisite(s)/Corequisite(s): ECEN 3250
ECEN 4980  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 8986)
Prerequisite(s)/Corequisite(s): Permission. Not open to non-degree graduate students.

ECEN 4990  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)/Corequisite(s): ECEN 4960. Not open to non-degree graduate students.