ELECTRICAL ENGINEERING (ELEN)

ELEN 1100 Introduction to ECE 1 Credit
Department: College of Engineering
This course introduces various topics in electrical and computer engineering. Technical topics include analog and digital systems. Technical skills include hands-on, design thinking, problem-solving, and computer-aided design. Other topics include information about electrical and computer engineering fields, ethics in engineering, curricula, and students' services, resources, and opportunities. 1-hour lab work includes signal processing with software and hardware implementations of digital and analog circuits.
Prerequisite(s)/Corequisite(s): MATH 2413
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 1301 Computers and Programming I 3 Credits
Department: College of Engineering
Study of digital computer principles, program organization, algorithm development, and implementation using high-level languages, such as C/C++ and/or Python. Topics include number systems, data types, input/output, logical operations, selections, repetitions, functions, arrays, and structures.
Prerequisite(s): MATH 2413
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 2301 Computers & Programming II 3 Credits
Department: College of Engineering
This course is a follow-up of ELEN 1301, introducing additional topics in digital computer principles, program organization, algorithm development, and implementation using high-level languages, such as C/C++ and/or Python.
Prerequisite(s): ELEN 1301
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 2320 Fund Instrumentation & Control 3 Credits
Department: College of Engineering
This course provides sophomore-level engineering students a comprehensive knowledge in instrumentation used in process control. With an emphasis on common industrial applications, this course covers the four fundamental instrumentation measurements of temprature, pressure, level and flow, in addition to position, humidity, moisture, and typical liquid and gas mearsuring instruments. Fundamental scientific principles and detailed illustrations will be used to present the course content.
Prerequisite(s)/Corequisite(s): ELEN 2411
Restriction(s):
Students with a class of Freshman may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 2411 Circuits Analysis I 4 Credits
Department: College of Engineering
This course introduces the concepts and basic laws in the analysis and design of DC and AC linear electric circuits. Topics include Ohm's law, Kirchhoff's laws, nodal and mesh analysis, Thevenin's and Norton's theorems, Superposition, Transient response, and Sinusoidal steady state analysis and response. Lab experience in the use of elementary electrical equipment and elements.
Prerequisite(s): MATH 2318 and PHYS 2426
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3101 Advanced Circuits Laboratory 1 Credit
Department: College of Engineering
Lab experience in the use of electrical equipment and elements, including the oscilloscope implemented with the current hardware and software approved by the department.
Prerequisite(s): MATH 2318 and PHYS 2426
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3310 Fundamentals of Electrical Engineering 3 Credits
Department: College of Engineering
For non-ECE majors, this course introduces the concepts and basic laws in the analysis and design of DC and AC linear electric circuits.
Prerequisite(s): MATH 2318 and PHYS 2426
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3312 Circuits Analysis II 3 Credits
Department: College of Engineering
This course is a follow up of ELEN 2411, introducing more advanced topics in the analysis and design of DC and AC linear electric circuits. Topics include Power calculations, polyphase circuits, Frequency response, resonance, magnetically coupled circuits, two-port networks, Fourier series, and Fourier and Laplace transform applications.
Prerequisite(s): ELEN 2411 and ELEN 3381 and MATH 3301
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3313 Signals, Systems and Transforms 3 Credits
Department: College of Engineering
High-level representation of systems in both continuous and discrete time domains; properties of systems; description of continuous and discrete signals and their properties; zero-pole representations; Laplace and Fourier-based analyses; the concept of sampling and the sampling theorem.
Prerequisite(s): ELEN 2411 and MATH 3301
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3320 Computer Networks 3 Credits
Department: College of Engineering
This course introduces students to computer network architectures and their widely used core protocols: TCP/IP protocol suites. Topics include IP addressing, IP routing, TCP/IP connection, data flow, and reliable transfer for the Internet.
Prerequisite(s): (MATH 3370 or INEN 3320) and (MATH 3321 or COSC 2375)
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3322 Electronics II 3 Credits
Department: College of Engineering
This course is a follow-up to ELEN 3421. Topics include frequency response analysis of transistor amplifiers, construction of bode blots, power transistors, and heat sinks, integrated circuit biasing, current mirrors, active load devices, op-amp internal structure, feedback circuits and stability, non-ideal effects in Analog ICs, applications of integrated circuits, and hardware and/or simulation assignments involving filter design, amplifier frequency response, current sources, and 555 timers.
Prerequisite(s): ELEN 3421 and ELEN 3312
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3328 Quantum Mechanics for Electrical Engineers 3 Credits
Department: College of Engineering
A targeted study of quantum mechanics for electrical engineers that develops deeper theoretical foundation for later study of electric, photonic and photoconductor engineering. Practical application of the finite-difference time-domain (FDTD) method to simulate the Schrodinger equation is used to develop an illustrative approach to modelling the behavior of electronic and photonic particles in semiconductor devises as well as in quantum telecommunications and computing hardware design.
Prerequisite(s): PHYS 2426 and MATH 2415
Corequisite(s): ELEN 2411
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3330 Operating Systems 3 Credits
Department: College of Engineering
An introduction to modern operating system design and implementation. The course will cover the major components of most operating systems. This discussion will cover the tradeoffs that can be made between performance and functionality during the design and implementation of an operating system. Topics include process management, memory management, file systems, and operating system support for distributed systems.
Prerequisite(s): ELEN 2301
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3340 Digital Integrated Circuits 3 Credits
Department: College of Engineering
This course will provide students with in-depth analysis and design capability required for state-of-the-art low-power and high-performance digital integrated circuits. Topics include the physics of operation and terminal I-V behavior of MOS devices, design and fabrication of the basic CMOS inverter and logic gates, static and dynamic circuits, pass-transistor logic, scaling-induced challenges, interconnect design, and VLSI testing basics.
Prerequisite(s): ELEN 3431 and ELEN 3421
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3371 Electromagnetics 3 Credits
Department: College of Engineering
Vector analysis, coordinate systems, static and quasi-static electric fields, electric potential, and dielectric forces. Maxwell's Equations, plane waves, transmission lines, matching networks, and Smith chart analysis.
Prerequisite(s): MATH 3301 and ELEN 2411 and ELEN 3381
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3381 Electrical Analysis 3 Credits
Department: College of Engineering
Application of the digital computer to analysis and design of electrical systems using numerical methods and commercial software such as MATLAB. Topics include variables, matrices, vectors, functions, flow control, data fitting, and numerical integration. 1-hour design content.
Prerequisite(s): MATH 2318 and MATH 2415
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3421 Electronics I 4 Credits
Department: College of Engineering
Topics include basic physics and operation of semiconductor electronic devices, analysis, and design of electronic circuits including diodes, BJT, MOSFET, and JFET transistors, and their applications, and operational amplifier concepts, circuits analysis, and design, and applications. 3-hour laboratory included.
Prerequisite(s): ELEN 2411 and MATH 2415
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3431 Digital System Design I 4 Credits
Department: College of Engineering
Introduction to the engineering of digital systems. Topics include logic gates, combinational and sequential circuits, finite-state machines, pipelining, and complete computer systems. 3-hour laboratory design content.
Prerequisite(s): ELEN 1100 and ELEN 1301
Corequisite(s): ELEN 2411
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3441 Fundamentals of Power Engineering 4 Credits
Department: College of Engineering
Review of three-phase circuit analysis. Principles of electromechanical energy conversion, operation of transformers, DC machines, synchronous machines, induction machines, and fractional horsepower machines. Introduction to electronic motor drives, power electronics, and power network models. The per unit system. Newton-Raphson power flow. Symmetrical three-phase faults. 3 Hour lab includes the operation, analysis, and performance of transformers, motors, and generators.
Prerequisite(s): ELEN 3312 and ELEN 3371
Corequisite(s): ELEN 3313, ELEN 3322
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 3451 Digital System Design II 4 Credits
Department: College of Engineering
This a follow-up course to ELEN 3431 introducing more topics in Digital System Design including Verilog Hardware Description Language.
The course provides a solid background in the use and application of Verilog HDL to digital hardware design. The course starts with the basic concepts of hardware description, then tackles structural, dataflow, and behavioral modeling in Verilog. Switch level modeling, timing analysis, and UDPs are also covered. Finally, the basics of all programmable logic devices and details of synthesis, mapping, and routing to FPGAs are studied.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4304 Advanced Topics 3 Credits
Department: College of Engineering
Topics are selected on the basis of the needs of an adequate number of students. May be repeated for credit when topics vary. Topics include artificial neural networks, digital signal processing, advanced electromagnetics, fault tolerant design, fiber optics, advanced power systems, and VLSI (very large scale integrated circuit) design.
May be Repeated for a maximum of 12 hours
Prerequisite(s): ELEN 3312 and ELEN 3322
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4305 Essentials of Low Power Design Methodologies 3 Credits
Department: College of Engineering
This introductory course covers the basic design of low-power circuitry in deep submicron technologies. The course also deals with the impact of soft errors in VLSI and introduces the reliability issues of low power designs. Topics studied include leakage power, short channel effects and basic leakage mechanisms such as sub-threshold and gate leakage, leakage minimization techniques such as transistor stacking, basic interconnect design, Synopsys HSpice simulation tool introduction, soft errors in advanced computer systems, error mechanisms, error rate, basic mitigation methodologies and impact of power optimizations on chip reliability.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4306 Senior Project Design I 3 Credits
Department: College of Engineering
This course is based on group design projects. Students work in teams to plan and develop proposals for their selected projects. Topics include engineering professionalism, ethics, design methodology, project management, development of standards, specifications and constraints, and evaluation of alternatives. Students make oral presentation and submit written reports on their proposed projects. Each student also prepares a technical paper and a poster on a separate topic. In lieu of the published prerequisites, other courses can be required by the instructor depending on the project. This is not to exceed the maximum of 11 hours set by the published prerequisites.
Prerequisite(s): ELEN 3313 and ELEN 3421 and ELEN 4486
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4307 Senior Project Design II 3 Credits
Department: College of Engineering
In this course, students complete the design projects proposed in ELEN 4306. Students perform the design synthesis, analysis, construction, testing, and evaluation of their team projects. This course is a study of engineering fields and profession, technology/society interface, new areas of electrical and computer engineering involvement, professional development, ethics, and standards. Students make oral presentation and submit written reports on their proposed projects. Each team also prepares a poster and a demo video on their project.
Prerequisite(s): ELEN 4306
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4308 Process Instrumentation & Measurement Systems 3 Credits
Department: College of Engineering
This course provides senior-level engineering students a comprehensive knowledge to instrumentation and measurement systems used in process control systems. With an emphasis on common industrial applications, this course covers the instrumentation measurements of temperature, pressure, level, and flow, in addition to position, humidity, moisture, and typical liquid and gas measuring instruments. Scientific principles and detailed illustrations will be used to present the course content.
Prerequisite(s): ELEN 2411 and PHYS 2426
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4309 Power System Monitoring and Protection 3 Credits
Department: College of Engineering
Reliability of electrical energy systems to a large extent is a consequence of the reliability of its protection system. Basic building blocks of the protection system are fuses, over current and distance relays and differential protection schemes. In this course, we will introduce their principles and applications to apparatus and system protection. we will also introduce both theory and practice of the numerical relays as well as protections of main components in power system. The course can be used as a first course in power system protection. It is useful to senior students and graduate students who wants to find opportunities related to power system protection and monitoring in substations, transmission and power plant, graduate students, practicing engineers as well as the research community.
Prerequisite(s): ELEN 3441
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4310 Electric Machines and Power Electric Drives 3 Credits
Department: College of Engineering
Course description: This is a senior and beginning level graduate course focusing on electric drive systems (power electronics driven electromechanical devices). The focus of the course will include permanent magnet synchronous machine drives (brushless dc) and induction motor drives. There will be a heavy emphasis on operation, physical modeling, and applied control. The topics are Introduction to advanced electric drive system, Basic Principle of advanced electric drive system, Reference Frame theory, Sinusoidal PWM and Space vector PWM inverters , DC drives, Dynamic analysis of Induction Machines, Analysis of Induction Machines in dq windings, Vector control of induction motor drives, Vector Control of Permanent magnet synchronous motor drives, Switched-reluctance motor (SRM) drives.
Prerequisite(s): ELEN 3441
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4311 Power System Stability Control 3 Credits
Department: College of Engineering
This course deals with the development of detailed models of power system components and their application in the analysis of the dynamic behavior of interconnected power systems in response to small and large disturbances. The main topics are alternate Energy Grid Integration Issues, Distributed Generation Technologies and the Economics of Distributed Resources in power system stability and control, introduction to Phasor measurements and Smart Grid Integration Issues, formulation of the power system stability problem, longer term stability and static and dynamic security assessments, and introduction to Power systems controls.
Prerequisite(s): ELEN 3441
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4312 Fundamentals of Power Electronics 3 Credits
Department: College of Engineering
The course starts with switched-mode DC-DC converters. First, basic circuit operation, including steady-state converter modeling and analysis, switch realization, discontinuous conduction mode, and transformer-isolated converters will be covered. Next, converter control systems are covered, including AC modeling of converters using averaged methods, small-signal transfer functions, and classical feedback loop design.
Prerequisite(s): ELEN 3322
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4314 Fundamentals of Digital Signal Processing 3 Credits
Department: College of Engineering
This course introduces the fundamentals of Digital Signal Processing. Topics include Discrete Fourier and z-Transforms, and digital filters analysis, design, implementation, and coefficient scaling and quantization.
Prerequisite(s): ELEN 3313
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4315 Introduction to Robotics 3 Credits
Department: College of Engineering
Robotics is a relatively young field of modern technology that crosses traditional engineering boundaries. Understanding the complexity of robots and their applications requires knowledge of electrical engineering, mechanical engineering, systems and industrial engineering, computer science, economics and mathematics. New disciplines of engineering, such as manufacturing engineering, applications engineering and knowledge engineering have emerged to deal with the complexity of the field of robotics and factory automation. This course is concerned with fundamentals of robotics, including kinematics, dynamics, motion planning, computer vision and control. The goal is to provide a complete introduction to the most important concepts in these subjects as applied to industrial robot manipulators, mobile robots and other mechanical systems. A complete treatment of the discipline of robotics would require several courses. Nevertheless, at the present time, the majority of robot applications deals with industrial robot arms operating in structured factory environments so that a first introductory course must include a rigorous treatment of such robots. Prerequisites: ELEN 3312 and ELEN 3322 with a minimum grade of C in each
Prerequisite(s): ELEN 3312 and ELEN 3322
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4317 PLC Programming 3 Credits
Department: College of Engineering
This course teaches electrical engineering undergraduate students the concepts, methods of analysis, and design of programmable logic controllers and systems. Topics include programmable logic controllers, ladder logic programming, and PLC operations.
Prerequisite(s): ELEN 3431
Restriction(s):
Enrollment limited to students with a class of Senior.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4318 Introduction to VLSI CAD Tools 3 Credits
Department: College of Engineering
The course introduces some basic industry-grade computer-aided-design (CAD) tool skills used to facilitate the design, verification and analysis of VLSI. The course begins with an introduction to CMOS design and process technologies. Then it covers basics interconnect design and noise analysis. Industry tools such as Synopsys Hspice, and Microwind layout tools will be introduced and studied using simple circuits. Overview of parasitic extraction, layout verification, interconnect design and timing analysis are also given. Optical interconnect introduction is also discussed. The course also introduces Verilog Programming, a desired skill sought by industry.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4320 Verilog Programming 3 Credits
Department: College of Engineering
This course discusses fundamental Verilog concepts of today's most advanced digital design techniques and it offers basic coverage of Verilog HDL from a practical design perspective. The course introduces Verilog HDL building blocks (design units) including modules, ports, processes and assignments. then it provides basic coverage of gate, dataflow (RTL), behavioral and switch modeling, timing and logic synthesis methodologies using simple circuits. Basic use of User-Defined Primitives (UPDs) will be described. Programmable logic and storage devices will also be covered. the course introduces many other essential techniques for creating tomorrow's complex digital design.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4321 Cyber Security 3 Credits
Department: College of Engineering
This course provides an overview of cyber security. The course primarily discusses the principles and design of cryptography and network security, which serves as the basis for cybersecurity. Topics include cryptographic methods, key distribution, protocols for authenticated and confidential communications, and the practice of network security.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4324 CMOS Digital IC DSN 3 Credits
Department: College of Engineering
Digital Integrated Circuit Analysis and Design. Design of CMOS switch level circuits, transmission gate logic, review of standard CMOS fabrication processes, device and interconnect analysis, scaling induced challenges on performance and testing, deep submicron issues, various simulation tools.
Prerequisite(s): ELEN 3322 and ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4325 Testing of Advanced VLSI Circuits 3 Credits
Department: College of Engineering
Following an introduction on the course design and analysis of digital COMS VLSI, this course covers important concepts of CMOS- based digital system design and testing. The first part of the course introduces basics on gate sizing, transmission, gate logic design, interconnect delay optimization, clock networks and power integrity challenges. The course then introduces VLSI testing issues. Students will learn how to use test sequences for stuck at faults, transistor stuck on/open faults for simple circuits and describe controllability and observability measures. The course will then study testability and pseudorandom test techniques. Introduction to alternative testing, methodologies such as IDDQ and IBMs picosecond light emission testing will also be given.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4336 Instrumentation & Automation Systems 3 Credits
Department: College of Engineering
Study of electronic instrumentation systems for performing engineering measurements on electrical, mechanical, and fluid systems. Design of modern computerized industrial control and automation systems. The topics covered include: architectures of instrumentation and industrial control and automation systems IAS; signal conditioning circuits; recording systems; measurement systems for: strain, force, displacement, velocity, acceleration, temperature, fluid mass/velocity, and vibration; digital-interface; PID-controls; open system buses.
Prerequisite(s): ELEN 4351
Restriction(s):
Students with a class of Freshman or Sophomore may **not** enroll.

Enrollment limited to students in the BS-ELEN program.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4351 Control Engineering 3 Credits
Department: College of Engineering
This course presents comprehensive treatments of the analysis and design of control systems based on the classical and modern control theories, applications of control engineering in space-vehicle, robotic, and modern manufacturing systems, and industrial operations involving control of temperature, pressure, humidity, flow, speed, etc. One hour design content.
Prerequisite(s): ELEN 3313
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4361 Communication Systems 3 Credits
Department: College of Engineering
Analysis and design of analog communications and digital communication systems. Topics include amplitude and frequency modulation, power and energy spectral density of communication signals, sampling and quantization of analog signals, baseband and binary bandpass digital modulation including line coding, pulse shaping, and both pulse and carrier modulation techniques, wireless communication system concepts, transmitter and receiver design concepts, and signal-to-noise ratio, bit error rate, and their relationship.
Prerequisite(s): ELEN 3431 and ELEN 3313 and (MATH 3370 or INEN 3320)
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4366 Image Processing Fundamentals 3 Credits
Department: College of Engineering
This course introduces the fundamentals of Image Processing. Topics include discussions of basics of digital imaging, intensity transformations and spatial filtering, filtering in frequency domain, image restoration and reconstruction, color image processing, image compression, and introduction to morphological image processing.
Prerequisite(s): ELEN 4314
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4371 Applied Electromagnetics 3 Credits
Department: College of Engineering
This course covers concepts starting from Maxwell's equations, antenna directivity, efficiency and gain, near and far fields, polarization, scattering parameters, and field equivalence principle as well as an overview of methods in computational electromagnetics. Students will also become familiar with various types of antennas and electromagnetic simulations.
Prerequisite(s): ELEN 3371
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4372 Antenna Theory 3 Credits
Department: College of Engineering
This course introduces the basics of antenna theory. Topics include antenna parameters, linear and loop antennas, horn antennas, reflector antennas, aperture antennas, printed antennas, dielectric resonators, and linear, planner, and circular antenna arrays as well as phased arrays.
Prerequisite(s): ELEN 3371
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4387 Computer Organization and Architecture 3 Credits
Department: College of Engineering
This course primarily discusses computer organization and architecture. Topics include advanced assembly language, microcomputer organization, computer memory system, interfacing with peripheral and I/O devices, CPU design, and microsequencer control unit design. One and a half hours of design content.
Prerequisite(s): ELEN 4486
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 4486 Embedded Microprocessor Systems 4 Credits
Department: College of Engineering
In-depth introduction to assembly language programming and microcomputer architecture. Topics include an overview of the programming model, the instruction execution cycle, an in-depth overview of the architecture of the specific CPU, its registers, Assembly instructions, addressing modes, and an introduction to Inline. The course includes 3-hour lab work.
Prerequisite(s): ELEN 3431
Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5301 Special Topics 3 Credits
Department: College of Engineering
An investigation into specialized study in advanced areas of engineering under guidance of a faculty member. This course may be repeated for credit when topics of investigation differ.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5303 Python Programming 3 Credits
Department: College of Engineering
This course covers the fundamentals of computer programming using Python as a programming language. Important elements of Python programming and its unique features will be covered. Its applications to solve some engineering problems will be presented.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5305 Low Power CMOS Design 3 Credits
Department: College of Engineering
Power consumption is one of the most important challenges of high-performance chips and portable devices. This introductory course covers the design of low-power circuitry in deep submicron technologies. The course also deals with soft errors in VLSI and studies the reliability of low power designs. Topics studied include leakage power, short channel effects and leakage mechanisms such as sub-threshold and gate leakage, Leakage minimization techniques such as transistor stacking, input control, dynamic threshold, interconnect design, Synopsis HSpice simulation, soft errors in advanced computer systems, error mechanisms, error rate, mitigation methodologies and impact of power optimizations on chip reliability.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5307 Computer Network Analysis & Design 3 Credits
Department: College of Engineering
This course primarily discusses computer networks from the perspective of analysis and design. Topics include network-based applications, layered network architectures, ARQ and analysis, performance analysis, packet switching, shortest path routing algorithms, design of the Internet architecture, and its widely used core protocols.
Prerequisite(s): MATH 3370
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5308 Computer Networks II 3 Credits
Department: College of Engineering
Mid-level course in computer networks; primarily discusses the widely used computer network protocols: TCP/IP protocol suites. The TCP/IP connection, data flow, routing, and reliable transfer are emphasized.
Prerequisite(s): ELEN 5307
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5311 Cyber Physical System & Security 3 Credits
Department: College of Engineering
In this course, we discuss cyber-physical systems and security, and the principles and practices of cryptography and network security. Following an introduction and review of the basics of cyber security, the course presents cyber-physical systems and security, security of wireless sensor networks, control systems, industrial control systems, power grids, embedded systems and RFID, cryptographic methods, key distribution, protocols for authenticated and confidential communications, and IPSec.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5312 Power Electronics 3 Credits
Department: College of Engineering
The course introduces the switched-mode converters. Includes steady-state converter modeling and analysis, switch realization, discontinuous conduction mode and transformer-isolated converters. Ac modeling of converters using averaged methods, small-signal transfer functions, feedback loop design and transformer design.
Prerequisite(s): ELEN 3322
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5313 Robot Motion Planning 3 Credits
Department: College of Engineering
Motion planning is the process of breaking down a desired movement task into discrete motions that satisfy movement constraints and possibly optimize some aspect of the movement. This course investigates the motion planning problem in robotics. Topics include motion of rigid objects by the configurations space and retraction approaches, shortest path motion, motion of linked robot arms, compliant motion, coordinated motion of several objects, robust motion with error detection and recovery, and motion in an unknown environment.
Prerequisite(s): ELEN 5301
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5314 Robotics Systems 3 Credits
Department: College of Engineering
This course reviews the interplay between control and robotics through introducing theory and demonstrating applications. It aims to provide an in-depth coverage of control design for robotic manipulators and mobile robots. We focus primarily on fundamental theory, control design methods, and their application on practical robotic systems. Topics may include modeling of robotic systems, linear control of robotic systems, Course projects will emphasize modeling, simulation and implementation of control systems for robot applications.
Prerequisite(s): ELEN 4351
Restriction(s):
Enrollment limited to students with a class of Graduate.

Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5316 Advanced Digital Communication 3 Credits
Department: College of Engineering
This course primarily discusses digital communication systems with an emphasis on the analysis of baseband/bandpass digital transmission systems with and without channel noise. Topics include transmission impairments, Shannon capacity, Nyquist method, baseband communications, carrier communications, FDM, sampling theory, pulse code modulation, digital representation of signals, theory of probability/ random processes and its applications in digital communications, digital transmission in the presence of noise, digital modulations, optimal design of transmitter and receiver, and M-ary communications.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5317 PLC Systems & Programming 3 Credits
Department: College of Engineering
This course is designed to provide an in depth understanding of the PLC Networking, Analog systems, advanced instruction set features, communications, diagnostics, modem and internet connections, remote I/O, Ethernet, motion control. Formal methods are introduced during this course to encourage the students to design a control algorithm. Formal methods are also important to verify and validate the control algorithm before implementing it.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5318 VLSI Design and CAD Tools 3 Credits
Department: College of Engineering
This course introduces various industry-grade computer-aided-design (CAD) tools used to facilitate the design, verification and analysis of complex VLSI. the course first deals with CMOS layout and fabrication then focuses on interconnect design and noise modeling. Industry tools such as Synopsis Hspice, Custom Explorer and Microwind layout and verification tool will be used for moderate-sized circuits. Parasitic extraction, layout verification, interconnect design and timing analysis are all studies. Optical interconnects are also discussed. The course also introduces Verilog programming, a desired skill sought by industry. Topics include design verification, gate-level, dataflow, behavioral and switch modeling, timing, logic synthesis and UDPs.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5320 Verilog Programming 3 Credits
Department: College of Engineering
This course discusses fundamental Verilog concepts of today's most advanced digital design techniques and it offered broad coverage of Verilog HDL from a practical design perspective. The course covers Verilog HDL building blocks (design units) including modules, ports, processes and assignments. then it provides full coverage of gate, dataflow (RTL), behavioral and switch modeling, timing and logic synthesis methodologies. Programmable logic and storage devices will also be covered. the course introduces many other essential techniques for creating tomorrow's complex digital design.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5324 CMOS Digital IC DSN 3 Credits
Department: College of Engineering
Digital Integrated Circuit Analysis and Design. Design of CMOS switch level circuits, transmission gate logic, review of standard CMOS fabrication processes, device and interconnect analysis, scaling induced challenges on performance and testing, deep submicron issues, various simulation tools.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5325 Advanced VLSI Design 3 Credits
Department: College of Engineering
Following an introduction on the design and analysis of digital CMOS VLSI circuits and systems, this course covers advanced topics such as gate sizing, transmission gate logic design, interconnect design, delay optimization, clock networks and power integrity challenges. Then the course focuses on VLSI Testing issues and covers subjects such as fault modeling, stuck at faults, transistor stuck on/open faults, controllability and observability measures, testability techniques, built-in self-testing, pseudo-random tests, IDDQ testing, alternative testing methodologies such as IBM Picosecond Light emission testing.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5336 Instrumentation Systems & Automation 3 Credits
Department: College of Engineering
he course starts with an overview of electronic instrumentation systems for performing engineering measurements on electrical, mechanical, and fluid systems and then progresses to more advanced topics and design of modern computerized industrial control and automation systems. The topics covered include: detailed discussion of physical principles of sensors' operation; architectures of IAS; principals of signal conditioning, recording and measurement systems for: strain, force, displacement, velocity, acceleration, temperature, fluid mass/velocity, and vibration; digital-interface; PID controls; open system buses; and other advanced topics in ISA.
Prerequisite(s): ELEN 4351
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5346 Digital Signal Processing 3 Credits
Department: College of Engineering
Sampling/reconstruction, quantization, discrete-time systems, digital filtering, Z-transforms, transfer functions, digital filter realizations, discrete Fourier transform (DFT) and fast Fourier transform (FFT), finite impulse response (FIR) and infinite impulse response (IIR) filter design, and digital signal processing (DSP)applications.
Prerequisite(s): ELEN 4314
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5350 Python Programming 3 Credits
Department: College of Engineering
This course covers the fundamentals of computer programming using Python as a programming language. Important elements of Python programming and its unique features will be covered. Its applications to solve some engineering problems will be presented.
Prerequisite(s): ELEN 1301
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5355 Electric Machines and Power Electronic Drives 3 Credits
Department: College of Engineering
Electric Machines and Power Electronic Drives. Introduction to advanced electric drive system, basic principle of advanced electric drive system, Reference Frame theory, Sinusoidal PWM and Space vector PWM inverters, DC drives, Dynamic analysis of Induction Machines, Analysis of Induction Machines in dq windings, Vector control of induction motor drives, Vector Control of Permanent magnet synchronous motor drives, Switched-reluctance motor (SRM) drives.
Prerequisite(s): MATH 3328 and ELEN 3312 and ELEN 3441 and ELEN 4351
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5356 Power System Stability and Control 3 Credits
Department: College of Engineering
Power System Stability and Control. This course deals with the development of detailed models of power system components and their application in the analysis of the dynamic behavior of interconnected power systems in response to small and large disturbances. The main topics are alternate Energy Grid Integration Issues, Distributed Generation Technologies and the Economics of Distributed Resources in power system stability and control, introduction to Phasor measurements and Smart Grid Integration Issues, formulation of the power system stability problem, longer term stability and static and dynamic security assessments, and introduction to Power systems controls.
Prerequisite(s): ELEN 3312 and ELEN 3441 and ELEN 4351
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5357 Power System Monitoring and Protection 3 Credits
Department: College of Engineering
Power System Monitoring and Protection. Reliability of electrical energy systems to a large extent is a consequence of the reliability of its' protection system. Basic building blocks of the protection system are fuses, over current and distance relays and differential protection schemes. In this course, we will introduce their principles and applications to apparatus and system protection. Technology of relaying has changed significantly in the last century. We will introduce both theory and practice of the numerical relays. The course can be used as a first course in power system protection. It should be also useful to graduate students, practicing engineers as well as research community.
Prerequisite(s): ELEN 3441
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5358 Electric System Modeling 3 Credits
Department: College of Engineering
Numerical techniques for the analysis of static and quasi-static field problems and associated phenomena in electrical devices and systems. Finite Element techniques for the solution of linear and non-linear, partial differential equations, boundary value problems. solution of forward and inverse problems. Emphasis on implementation and applications to practical problems. Therefore, the course is basically software-learning. May be Repeated for a maximum of 6 hours
Prerequisite(s): ELEN 3441
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5366 Image Processing 3 Credits
Department: College of Engineering
This course introduces the principals of Image Processing. Topics include discussions of basics of digital imaging, an overview of human visual system, intensity transformations and spatial filtering, filtering in frequency domain, image restoration and reconstruction (including the optimum approach), discussion of color modes, color image processing, wavelets and multiresolution image processing, image compression, and introduction to morphological image processing.
Prerequisite(s): ELEN 4314
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5371 Computational Electromagnetics 3 Credits
Department: College of Engineering
This course covers concepts regarding electromagnetics, antennas, RF and microwaves, computational electromagnetics as well as design and simulation of various types of antennas and radar cross section using electromagnetic simulation software. In addition, some specific types of antennas such as broadband and frequency-independent antennas will be covered.
Prerequisite(s): ELEN 3371
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 5372 Printed Antennas & RF Circuits 3 Credits
Department: College of Engineering
This course introduces the printed antennas and microstrip circuits such as patch antennas, inverted L/F antennas, monopole and dipole antennas, transmission lines, feeding networks, filters, and directional couplers, for wideband, ultrawideband, and multiband applications.
Prerequisite(s): ELEN 4372
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6110 Professional Seminar 1 Credit
Department: College of Engineering
Advanced topics suitable for research along with research procedures will be discussed. Field study organization and content together with doctoral research problems and progress will be represented. Topics will vary each semester and course may be repeated for credit. Registration and completion for three semesters is required of all doctoral candidates.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6301 Special Topics 3 Credits
Department: College of Engineering
An investigation into specialized study in advanced areas of engineering under guidance of a faculty member. This course may be repeated for credit when topics of investigation differ.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6303 Advanced Python Programming 3 Credits
Department: College of Engineering
This course covers advanced topics in computer programming using Python as a programming language and its applications in advanced computational research.
Restriction(s):
Graduate or Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6305 Low Power and Robust CMOS Design 3 Credits
Department: College of Engineering
the increased power consumption in portable devices has been one of the most important challenges in VLSI design which occurs due to the high performance of chips. The aim of this course is to create reliable low power designs that are also tolerant to soft errors. the course starts with a discussion on increasing leakage power consumption and identifies various mechanisms responsible for the increase such as sub-threshold leakage and gate and junction leakage. It then covers circuit-level leakage control techniques used by industry such as transistor stacking and multi VTH and body-biasing. The second part of the course addresses soft error issues in commercial VLSI. The impact of lower power designs on radiation tolerance is studies and results are shown using the industry grade HSpice simulation tool involving advanced benchmark circuits.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6307 Advanced Computer Network Analysis and Design 3 Credits
Department: College of Engineering
This is an advanced analysis and design course in computer networks. Topics include ARQ and analysis, network modeling and performance analysis using queue theory, packet switching, shortest path routing algorithms, design of the Internet architecture, design of the widely used Internet core protocols, and the research-oriented projects related to performance modeling and analysis of computer networks.
Prerequisite(s): MATH 3370
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6311 Advanced Cyber Physical System and Security 3 Credits
Department: College of Engineering
Following an introduction and review of the basics of cyber security, cyber-physical systems and security, and cryptography and network security, this course moves to advanced topics in cyber-physical systems and security, cryptography and network security, and research-oriented projects related to cyber security.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6314 Advanced Robotics Systems 3 Credits
Department: College of Engineering
This course reviews the interplay between control and robotics through introducing theory and demonstrating applications. It aims to provide an in-depth coverage of control design for robotic manipulators and mobile robots. We focus primarily on fundamental theory, control design methods, and their application on practical robotic systems. Topics may include modeling of robotic systems, linear/nonlinear control of robotic systems, control of under-actuated robotic systems, optimal control, adaptive control, behavior-based robots. Course projects will emphasize modeling, simulation and practical implementation of control systems for robot applications.
Prerequisite(s): ELEN 4351
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6317 Advanced PLC Systems and Programming 3 Credits
Department: College of Engineering
This course is designed to provide an in depth and advanced understanding of the PLC Networking, Analog systems, advanced instruction set features, communications, diagnostics, modem and internet connections, remote I/O, Ethernet, motion control. Further, students will learn about the PLC troubleshooting and networking. Formal methods are introduced during this course to encourage the students to design a control algorithm. Formal methods are also important to verify and validate the control algorithm before implementing it. The course enables the students to independently use the content of this course in their research.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6318 VLSI CAD Engineering 3 Credits
Department: College of Engineering
This course will provide essential skills in CMOS Layout Design, Parasitic Extraction and Verification, Interconnect Design and modeling, design and hardware verification and logic synthesis. The course will introduce numerous industry-grade computer-aided design (CAD) tools used to facilitate the design, verification and analysis of complex VLSI circuits and systems. Interconnect challenges and future solutions to scaling induced problems will also be provided.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6320 Justification Engineering Proj 3 Credits
Department: College of Engineering
The preparation of proposals for advanced engineering work. The student will be given individual assistance in preparing a proposal for his field of study.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Satisfactory/Unsatisfactory, Registrar do not use FN, Registrar do not use FS, Thesis/Dissertation, Standard Letter

ELEN 6325 Advanced VLSI Design and Testing Issues 3 Credits
Department: College of Engineering
This course covers important concepts in Advance CMOS digital system including signal integrity issues and testing challenges. First part of the course focuses on interconnect planning and optimization, clock skew minimization and power integrity issues and various solutions to these problems. The course then focuses on advance testing issues facing testing industry and the commercial ATE. Fault modeling, collapsing, controllability and observability measures will be studied. We cover state of the art testability design including built-in self-testing, scan testing and ad hoc methodologies. The course also studies various industry adopted non-contact test methodologies such as electron beam probing, scanning force microscopy and IDDQ testing. Novel optical contactless testing methods such as all-silicon optical testing and IBM's light emission testing (PICA) will also be covered.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6330 Verilog HDL Programming and Applications 3 Credits
Department: College of Engineering
The main objective of this course is to provide students with a theoretical background to and practical experience with the tools, techniques and methods of solving challenges related to modeling complex systems using the Verilog hardware description language (HDL). Design and verification of digital systems using hardware description languages and commercially-available computer-aided design (CAD) tools. Use a Hardware Description Language (HDL) to emulate hardware logic gate operation, establish data flows and model desired logic behavior. Simulate hardware designs using HDL and verify the results using complex benchmark circuits.
Prerequisite(s): ELEN 3431
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6346 Statistical DSP & Modeling 3 Credits
Department: College of Engineering
This course discusses the advanced topics of Statistical DSP and modeling approaches. These topics include an overview of Discrete Random Processes, Special types of DRPs including AR, MA, and ARMA processes, Wiener and Adaptive filtering, Non-parametric and Parametric spectral estimation, Frequency estimation, and use of stochastic modeling for parameter estimation; and other advanced topics.
Prerequisite(s): ELEN 4314
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6350 Advanced Python Programming 3 Credits
Department: College of Engineering
This course covers advanced topics in computer programming using Python as a programming language and its applications in advanced computational research.
Prerequisite(s): ELEN 1301
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6366 Image Processing 3 Credits
Department: College of Engineering
This course introduces the advanced topics of Image Processing. These topics include discussions of basics of digital imaging, an overview of human visual system (its models, physiology, and optical illusions), intensity transformations and spatial filtering, filtering in frequency domain, image restoration and reconstruction (including the model-based and optimum approaches), in-depth discussion of color modes, color image processing, wavelets and multiresolution image processing, image compression, morphological image processing (including grey-scale morphology), and Image segmentation.
Prerequisite(s): ELEN 4314
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6372 Antennas Design & Analysis 3 Credits
Department: College of Engineering
This course introduces the printed antennas and microstrip circuits, and their design and analysis using computational electromagnetic tools such FDTD, MoM or FE.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Standard Letter, Registrar do not use FN, Registrar do not use FS

ELEN 6601 Engineering Prac-Field Studies 6 Credits
Department: College of Engineering
An internship period under personal supervision. Approval must be obtained from the student's graduate committee. Usually, a formal proposal will be required. May be taken for either six or twelve hours credit per semester. Must be repeated for credit until field study is completed.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Satisfactory/Unsatisfactory, Registrar do not use FN, Registrar do not use FS

ELEN 6602 Engineering Prac-Field Study 6 Credits
Department: College of Engineering
An internship period under personal supervision. Approval must be obtained from the student's graduate committee. Usually, a formal proposal will be required. May be taken for either six or twelve hours credit per semester. Must be repeated for credit until field study is completed.
Restriction(s):
Undergraduate level students may **not** enroll.

Grade Mode(s): Satisfactory/Unsatisfactory, Registrar do not use FN, Registrar do not use FS