

ELECTRICAL ENGINEERING (ELEN)

ELEN 209 Computer Programming and Algorithms 4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110

Introduction to C language programming and common algorithms; computer systems; simple C programs; basic language constructs; file I/O; modular programming and functions; arrays and matrices; pointers and strings; simple data structures; searching, sorting, and numerical algorithms; algorithmic complexity.

ELEN 214 Electrical Circuit Theory 4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): PHYS 217
Corequisite(s): MATH 318

Fundamental laws, electrical elements and sources, energy and power DC analysis of linear circuits Node and mesh analysis Operational amplifiers and op-amp circuits, Thevenin and Norton theorems Sinusoidal steady-state response and the phasor concept. Introductory concepts on complex frequency, average power in AC circuits Transient responses.

ELEN 215 Principles of Electrical Engineering 3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261 and PHYS 217, MATH 261; PHYS 217

This course covers basic principles of electric circuit analysis and an introduction to electronics tailored for engineering students not specializing in electrical and computer engineering. Prerequisite: MATH 261; PHYS 217.

ELEN 248 Digital Systems Design 4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 162

Introduction to digital logic Topics include numbers and coding systems; Boolean algebra with applications to logic systems; Karnaugh and Quine-McCluskey minimization; combinatorial logic design; flip-flops; sequential network design; and design of digital logic circuits

ELEN 250 Machine Learning for Electrical Engineering 3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ENGR 110 and MATH 261

Engineering application-focused introduction to machine learning covering key machine learning concepts, guidance on selecting machine learning models, and application of python-based tools for data preparation, model development, and performance evaluation; practical engineering use-cases for machine learning from electronics, energy, motors, robotics, security, computer systems, and health; machine learning laboratory project including dataset management, ML model development, visualization, and deployment to an IoT platform showcasing ML expertise

ELEN 303 Random Signals and Systems 3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 261

This course offers a comprehensive exploration of random signals and their engineering applications It includes probability theory, stochastic processes, and random variables, covering Gaussian and non-Gaussian processes, spectral analysis, correlation functions, and signal processing techniques Practical applications in communication, control systems, and information theory are emphasized, preparing students for complex system analysis and design Hands-on experiments and case studies enhance theoretical learning with practical implementation.

ELEN 314 Signals and Systems 3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and MATH 318

Introduction to the continuous-time and discrete-time signals and systems; time domain characterization of linear time-invariant systems; Fourier analysis; filtering; sampling; modulation techniques for communication systems.

ELEN 322 Electric and Magnetic Fields 3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214 and MATH 321

Vector analysis; static electric field; steady electric currents; static magnetic fields; time-varying fields and Maxwell's equations; plane electromagnetic waves.

ELEN 325 Electronics 4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): MATH 321 and ELEN 214

Introduction to electronic systems; linear circuits; operational amplifiers and applications; diodes, field effect transistors, bipolar transistors; amplifiers and nonlinear circuits.

ELEN 335 Measurements and Instrumentation 4 Credits

Grade Mode: Standard Letter
Prerequisite(s): ELEN 325, ELEN 325 and ELEN 314

This course introduces the principles, devices, and methods used in the instrumentation and measurement of electrical and non-electrical signals. Students will learn to select, calibrate, and operate instruments, as well as interpret measurement data. Topics include introduction to measurement systems, transducers and sensors, signal conditioning, calibration and standards, and applications in engineering. The course includes analog and digital measurements, analog to digital conversion (ADC) and digital to analog conversion (DAC) techniques. Prerequisite: ELEN 325 and ELEN 314.

ELEN 340 Electric Energy Conversion 4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 214

Fundamental topics in power and energy systems; phasors; three-phase circuits; self and mutual inductance; transformers; electromechanical systems; synchronous and induction machines; advanced concepts in electric energy conversion; DC-DC converters; inverters and rectifiers; solar and wind energy systems; DC and single-phase machines.

ELEN 349 Microprocessors and Embedded Systems **4 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 209 and ELEN 248

This course is an introduction to the operation, interfacing, and applications of microprocessor-based systems, and real-time embedded system design. Topics include memory organization, microprocessor architecture, embedded C programming, real-time programming, data path and control design of microprocessors.

ELEN 350 Computer Architecture and Design **4 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 248

Computer architecture and design; use of register transfer languages and simulation tools to describe and simulate computer operation; central processing unit organization, microprogramming, input/output and memory system architectures.

ELEN 370 Physical Properties of Materials **3 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): PHYS 217

This course offers a comprehensive understanding of the fundamental principles governing the behavior and characteristics of materials, with focus on those used in electrical and electronic devices. The course explores the relationship between the physical properties of materials and their performance in various engineering applications, with an emphasis on materials commonly employed in semiconductor devices, integrated circuits, and electronic components. It includes an introduction to properties of conductors, semi-conductors, and insulators. Definitions of stress and strain and mechanical behavior of solids. Advanced characterizations of selected materials; circuit models for resistors, capacitors, inductors, junction, diodes, detectors, field-effect transistors, etc. Structure/property/ processing relationships will be also examined across a wide spectrum of materials including metals, ceramics, polymers and properties including electrical, magnetic, optical, thermal, mechanical, chemical and biocompatibility will be investigated. Emerging Materials and Technologies applied for electrical, and electronics will be also studied.

ELEN 391 Internship **0 Credits**
 Grade Mode: Pass/Non Pass

Participation in an approved high-impact learning practice, such as engaging with industry, research entities, or startup companies.

ELEN 403 Senior Design Project I **3 Credits**
 Grade Mode: Standard Letter
 Prerequisite(s): ELEN 349 and ELEN 314 and ELEN 370 and ELEN 325 and ELEN 303 and ELEN 322 and ELEN 335 and ELEN 340 and ELEN 350

This course is conducted as a guided project design course over a two-semester period, with the class divided into teams, each assigned a specific design project. Periodic progress reports, a final written report, an oral presentation and project demonstration are required. Cost analysis, societal impact, safety issues, evaluation of design alternatives and application of engineering principles will be emphasized. A series of tutorials will be presented to provide student teams with insight into important system level considerations and tradeoffs.

ELEN 404 Senior Design Project II **3 Credits**
 Grade Mode: Standard Letter
 Prerequisite(s): ELEN 403

Continuation of ELEN 403. This course is conducted as a guided project design course over a two-semester period, with the class divided into teams, each assigned a specific design project. Periodic progress reports, a final written report, an oral presentation and project demonstration are required. Cost analysis, societal impact, safety issues, evaluation of design alternatives and application of engineering principles will be emphasized.

ELEN 410 Automatic Control Systems **3 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 314 and MATH 318

Modeling and response of dynamic systems. Transfer functions, poles and zeros and their significance to transient and steady state response of feedback systems. Analysis of stability of closed-loop systems. Steady state errors and transient performance of closed-loop systems. Design of feedback control systems by root locus techniques and by frequency domain methods. Laboratory projects include modeling, controller design, controller realization, system performance evaluation, and simulation studies.

ELEN 412 Power Electronics **4 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 214

Modeling and response of dynamic systems. Transfer functions, poles and zeros and their significance to transient and steady state response of feedback systems. Analysis of stability of closed-loop systems. Steady state errors and transient performance of closed-loop systems. Design of feedback control systems by root locus techniques and by frequency domain methods. Laboratory projects include modeling, controller design, controller realization, system performance evaluation, and simulation studies.

ELEN 414 Electric Power Systems **4 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 214 and ELEN 314

This course will introduce students to basic methods of electric power systems. Topics include AC circuits, phasors, complex power and complex impedance, transformers, per unit system, transmissions lines, power flow, economic dispatch, real and reactive power control, symmetric and unsymmetric faults, transient stability, relaying and protection.

ELEN 416 Electric Machines and Drives **4 Credits**
 Grade Mode: Standard Letter, Audit/Non Audit
 Prerequisite(s): ELEN 214 and ELEN 322

This is an introductory course on electric machines and drive systems and their application in HEV/PHEV powertrain and other industrial and residential systems. The objectives are to familiarize the students with the basic concepts of electromechanical energy conversion and electric drive systems. Students are expected to be able to analyze and design electric drive systems for automotive, industrial, and residential applications. The topics covered in this course include DC machines, induction machines, permanent magnet synchronous machines, and switched reluctance motors and drives. Case studies in automotive applications such as electric and hybrid drivetrains, industrial and residential electric variable speed drive systems, will be discussed.

ELEN 418 Renewable Electric Power Systems

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 340

This course is an introduction to traditional power grids as well as renewable electric power systems. This course covers long-distance transmission of electric power with emphasis on admittance and impedance modeling of components and systems, complex power-flow studies, symmetrical and unsymmetrical fault calculations, economic operation of large-scale generation and transmission systems, an overview of emerging renewable energy technologies (eg wind and solar) and the impact of grid integration of renewable energy on power grids.

ELEN 420 Linear Control Systems

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit

Application of state variable and frequency domain techniques to modeling, analysis and synthesis of single input, single output linear control systems.

ELEN 429 Machine Learning for Signal Processing

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit

Principles of pattern recognition and machine learning and electrical and computer engineering applications in signal estimation, detection and classification, detection of patterns in engineering systems and communications networks, assessment of normality and abnormality patterns in biomedical engineering applications and cyber security of power systems.

ELEN 430 Digital Signal Processing

4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314

Digital signal processing; discrete-time signals and systems, linear shift-invariant systems, the discrete Fourier transform and fast Fourier transform algorithm, and design of finite impulse response and infinite impulse response digital filters.

ELEN 431 Digital Communications

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit

Digital transmission of information through stochastic channels; analog-to-digital conversion, entropy and information, signal detection, the matched-filter receiver, probability of error; baseband and passband modulation, signal space representation of signals, PAM, QAM, PSK, FSK; block coding, convolutional coding; synchronization; simulation of digital communication systems.

ELEN 432 Wireless Communications

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314

This course provides an introduction to the fundamentals of modern wireless communication. The focus of this course will be on the (i) basic signal propagation issues and channel impairments, (ii) modulation schemes and bandwidth/power trade-offs, and (iii) overcoming channel impairment using equalizers, diversity and channel coding. Additionally, case studies will examine current wireless LANs and cellular system

ELEN 434 Radar and Remote Sensing

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and ELEN 322

This course delves into fundamental radar concepts, including radar waveforms, signal processing, antenna design, and radar cross-section analysis. It also covers remote sensing techniques, such as passive and active sensing, multispectral and hyperspectral imaging, synthetic aperture radar (SAR), and lidar systems. Students learn about system design considerations and implementation, including system requirements analysis and hardware/software design. Advanced topics like laser theory and applications are explored in detail during the spring session, complementing the foundational concepts covered in the course.

ELEN 436 Image Processing

4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 314 and ELEN 303

Fundamentals of physics and the engineering principles of medical imaging systems; focus on magnetic resonance imaging, x-ray computer tomography, ultrasonography, optical imaging and nuclear medicine; includes systems, sources, energy tissue interaction, image formation and clinical examples; virtual labs, on- and off-campus lab tours.

ELEN 438 Power Electronics

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit

Electric power conditioning and control; characteristics of solid state power switches; analysis and experiments with AC power controllers, controlled rectifiers, DC choppers and DC-AC converters; applications to power supplies, airborne and spaceborne power systems.

ELEN 440 Principles of Artificial Intelligence

4 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 250 and ELEN 349

Basic concepts and methodology of artificial intelligence from a computer engineering perspective. Emphasis is placed on the knowledge representations, reasoning and algorithms for the design and implementation of intelligent systems. Introduction to an AI language and representative intelligence systems. A design project is required.

ELEN 442 Deep Learning for Robotics

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 250 and ELEN 350

This course covers the application of deep learning techniques in robotics, focusing on perception, control, and decision-making. Students will learn about applying deep learning models to robotic vision, navigation, and manipulation. Through hands-on projects, students will design and train deep learning models for real-time robotic systems.

ELEN 446 VLSI Design

3 Credits

Grade Mode: Standard Letter, Audit/Non Audit
Prerequisite(s): ELEN 325

This course covers the design and implementation of integrated circuits, including CMOS technology, digital logic design, and layout techniques. The course emphasizes hands-on experience with VLSI design tools and the development of practical skills in designing, simulating, and testing VLSI circuits.

ELEN 448 CMOS Digital Circuit Design **3 Credits**

 Grade Mode: Standard Letter, Audit/Non Audit

 Prerequisite(s): ELEN 325

This course focuses on the design and analysis of CMOS digital circuits. Students will explore the principles of CMOS technology, logic gate design, and circuit optimization techniques. Emphasis is placed on understanding the trade-offs in performance, power, and area. Practical experience will be gained through the use of industry-standard design tools for simulation and layout.

ELEN 449 Microprocessor Systems Design **3 Credits**

 Grade Mode: Standard Letter, Audit/Non Audit

Introduction to microprocessors; 16/32 bit single board computer hardware and software designs; chip select equations for memory board design, serial and parallel I/O interfacing; ROM, static and dynamic RAM circuits for no wait-state design; assembly language programming, stack models, subroutines and I/O processing.

ELEN 455 Digital Communications **3 Credits**

 Grade Mode: Standard Letter, Audit/Non Audit

Digital transmission of information through stochastic channels; analog-to-digital conversion, entropy and information, Huffman coding; signal detection, the matched-filter receiver, probability of error; baseband and passband modulation, signal space representation of signals, PAM, QAM, PSK, FSK; block coding, convolutional coding; synchronization; communication through fading channels; spread-spectrum signaling; simulation of digital communication systems.

ELEN 489 Selected Topics in Electrical Engineering **1-3 Credits**

 Grade Mode: Standard Letter, Audit/Non Audit

Advanced or applied topics in electrical engineering offered according to student's interest and availability of instructors and equipment.

 Lecture hours, laboratory, and/or computation period to be arranged.