Courses

**ECEN 214 Electrical Circuit Theory**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
Resistive circuits: circuit laws, network reduction, nodal analysis, mesh analysis; energy storage elements; sinusoidal steady state; AC energy systems; magnetically coupled circuits; the ideal transformer; resonance; introduction to computer applications in circuit analysis.  
**Prerequisites:** ENGR 111, ENGR 112, PHYS 208, CHEM 107, CHEM 117 with a grade of C or better; MATH 308 with a grade of C or better or registration therein; admission to electrical and computer engineering.

**ECEN 215 Principles of Electrical Engineering**  
**Credits 3. 2 Lecture Hours. 2 Lab Hours.**  
Fundamentals of electric circuit analysis and introduction to electronics for engineering majors other than electrical and computer engineering.  
**Prerequisites:** ENGR 111, ENGR 112, PHYS 208, CHEM 107, CHEM 117 with a grade of C or better; MATH 308 with a grade of C or better or registration therein; admission to an engineering major.

**ECEN 222/CSCE 222 Discrete Structures for Computing**  
**Credits 3. 3 Lecture Hours.**  
Provide mathematical foundations from discrete mathematics for analyzing computer algorithms, for both correctness and performance; introduction to models of computation, including finite state machines and Turing machines.  
**Prerequisite:** MATH 151.  
**Cross Listing:** CSCE 222/ECEN 222.

**ECEN 248 Introduction to Digital Systems Design**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
Combinational and sequential digital system design techniques; design of practical digital systems.  
**Prerequisite:** ENGR 111, ENGR 112, PHYS 208, CHEM 107, CHEM 117 with a grade of C or better; MATH 152 with a grade of C or better; admission to electrical and computer engineering.

**ECEN 285 Directed Studies**  
**Credits 1 to 4. 1 to 4 Other Hours.**  
Problems of limited scope approved on an individual basis intended to promote independent study.  
**Prerequisite:** Approval of department head.

**ECEN 289 Special Topics in...**  
**Credits 1 to 4. 1 to 4 Other Hours.**  
Selected topics in an identified area of electrical engineering. May be repeated for credit.  
**Prerequisite:** Approval of instructor.

**ECEN 291 Research**  
**Credits 1 to 4. 1 to 4 Other Hours.**  
Research conducted under the direction of faculty member in electrical engineering. May be repeated 3 times for credit.  
**Prerequisites:** Freshman or sophomore classification and approval of instructor.

**ECEN 303 Random Signals and Systems**  
**Credits 3. 3 Lecture Hours. 1 Lab Hour.**  
Concepts of probability and random variables necessary for study of signals and systems involving uncertainty; applications to elementary problems in detection, signal processing and communication.  
**Prerequisites:** Grade of C or better in MATH 308; junior or senior classification.

**ECEN 314 Signals and Systems**  
**Credits 3. 3 Lecture Hours.**  
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.  
**Prerequisites:** Grade of C or better in ECEN 214; MATH 308; junior or senior classification.

**ECEN 322 Electric and Magnetic Fields**  
**Credits 3. 3 Lecture Hours. 1 Lab Hour.**  
Vector analysis, Maxwell's equations, wave propagation in unbounded regions, reflection and refraction of waves, transmission line theory; introduction to waveguides and antennas.  
**Prerequisites:** ECEN 214, PHYS 208, and MATH 311 with a grade of C or better; junior or senior classification.

**ECEN 325 Electronics**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
Introduction to electronic systems; linear circuits; operational amplifiers and applications; diodes, field effect transistors, bipolar transistors; amplifiers and nonlinear circuits.  
**Prerequisite:** MATH 311 with a grade of C or better; ECEN 314 with a grade of C or better, or registration therein.

**ECEN 326 Electronic Circuits**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
Basic circuits used in electronic systems; differential and multistage amplifiers; output stages and power amplifiers; frequency response, feedback circuits, stability and oscillators, analog integrated circuits, active filters.  
**Prerequisites:** Grade of C or better in ECEN 314 and ECEN 325; junior or senior classification.

**ECEN 338 Electromechanical Energy Conversion**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
Introduction to magnetic circuits, transformers, electromechanical energy conversion devices such as dc, induction and synchronous motors; equivalent circuits, performance characteristics and power electronic control.  
**Prerequisite:** ECEN 214.

**ECEN 350/CSCE 350 Computer Architecture and Design**  
**Credits 4. 3 Lecture Hours. 3 Lab Hours.**  
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.  
**Prerequisites:** Grade of C or better in ECEN 248; junior or senior classification.  
**Cross Listing:** CSCE 350/ECEN 350.

**ECEN 370 Electronic Properties of Materials**  
**Credits 3. 3 Lecture Hours. 1 Lab Hour.**  
Introduction to basic physical properties of solid materials; some solid state physics employed, but major emphasis is on engineering applications based on semiconducting, magnetic, dielectric and superconducting phenomena.  
**Prerequisite:** Grade of C or better in PHYS 222; junior or senior classification.
ECEN 403 Electrical Design Laboratory I
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Application of design process and project engineering as practiced in industry; team approach to the design process; development of a project proposal; proposed project implemented in ECEN 404.
Prerequisites: COMM 205 or COMM 243 or ENGL 210; grade of C or better in ECEN 314, ECEN 325, ECEN 350/CSCE 350; grade of C or better in ECEN 303, ECEN 322, ECEN 370 or grade C or better in CSCE 315, ECEN 449, STAT 211 or ECEN 303; senior classification.

ECEN 404 Electrical Design Laboratory II
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Continuation of ECEN 403; application of the design process and project engineering as practiced in industry; team approach to the design process; completion of project based on proposal from ECEN 403; includes testing, evaluation and report writing.
Prerequisites: Grade of C or better in ECEN 403; senior classification.

ECEN 405 Electrical Design Laboratory
Credits 3. 1 Lecture Hour. 6 Lab Hours.
Introduction to the design process and project engineering as practiced in industry; student teams apply the design process by developing a project from proposal through test and evaluation.
Prerequisites: ENGL 210 or 301, completion of selected major ﬁeld courses, senior classiﬁcation and project approval.

ECEN 410 Medical Imaging
Credits 4. 3 Lecture Hours. 2 Lab Hours.
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.
Prerequisites: Grade of C or better in MATH 222 or MATH 251 or MATH 253; ECEN 444 or grade of C or better in ECEN 314; junior or senior classiﬁcation.

ECEN 411 Introduction to Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to the basic physics of magnetic resonance, the principles of MR imaging and spectroscopy, the major contrast mechanisms in MRI and MR imaging system hardware; development of pulse sequences for different imaging methods, including ﬂow and spectroscopic imaging; will build RF coils.
Prerequisites: Grade of C or better in MATH 251 and PHYS 208; junior or senior classiﬁcation.

ECEN 412 Ultrasound Imaging
Credits 3. 3 Lecture Hours.
Mathematical analysis of wave propagation, scattering of ultrasound in biological tissues, electronic transducer arrays for the beam forming, models of the received signals and signal processing methods for medical ultrasound imaging of tissues; includes discussions of research related to fundamental ultrasound imaging concepts.
Prerequisites: Grade of C or better in ECEN 314; junior or senior classiﬁcation.

ECEN 414 Biosensors
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Hands-on lab experience in the development of miniaturized biosensors; includes microﬂuidic devices for biosensing.
Prerequisite: Senior classiﬁcation or approval of instructor.

ECEN 415 Physical and Economical Operations of Sustainable Energy Systems
Credits 3. 3 Lecture Hours.
Operational issues for sustainable electric energy systems; basic relevant topics in engineering, optimization and economic concepts; modular view of individual electric energy processing components; physical and market operations in electricity industry in support of sustainable energy integration; computer simulations and demonstrations to create and evaluate examples of power systems.
Prerequisites: Grade of C or better in ECEN 214; ECEN 420; ECEN 460; junior or senior classiﬁcation.

ECEN 419 Genomic Signal Processing
Credits 3. 3 Lecture Hours.
Fundamentals of molecular biology; application of engineering principles to systems biology; topics include unearthing intergene relationships, carrying out gene-based classiﬁcation of disease, modeling genetic regulatory networks, and altering their dynamic behavior.
Prerequisites: Grade of C or better in ECEN 314; junior or senior classiﬁcation.

ECEN 420 Linear Control Systems
Credits 3. 3 Lecture Hours.
Application of state variable and frequency domain techniques to modeling, analysis and synthesis of single input, single output linear control systems.
Prerequisites: Grade of C or better in ECEN 314 and MATH 308; junior or senior classiﬁcation.

ECEN 421 Digital Control Systems
Credits 3. 3 Lecture Hours.
Feedback systems in which a digital computer is used to implement the control law; Z-transform and time domain methods serve as a basis for control systems design. Effects of computer word length and sampling rate.
Prerequisite: ECEN 420 or equivalent.

ECEN 422 Control Engineering and Design Methodology
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Modeling, speciﬁcations, rating and operating principles of sensors, actuators and other control system components; experiments on conceptual design, simulation and physical implementation of control systems.
Prerequisite: ECEN 420 or equivalent.

ECEN 424 Fundamentals of Networking
Credits 3. 3 Lecture Hours.
Foundations of computer networking; layered architecture of the Internet, analysis of protocols, new-age networks such as the Web and social networks; computer network programming and off-line analysis of real network data.
Prerequisites: Grade of C or better in ECEN 303 or STAT 211; junior or senior classiﬁcation.

ECEN 425 Radio Frequency and Microwave Engineering
Credits 3. 3 Lecture Hours.
Fundamental Radio Frequency (RF) and microwave circuit analysis; scattering and ABCD matrices, return loss, insertion loss; transmission lines, lumped elements, impedance matching; theory, analysis and design of basic RF and microwave passive circuits; use of commercial CAD programs for RF and microwave circuit design and simulation.
Prerequisites: Grade of C or better in ECEN 322; junior or senior classiﬁcation.
ECEN 444 Digital Signal Processing
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Improvement of pictorial information using spatial and frequency domain techniques; two-dimensional discrete Fourier transform; image filtering, enhancement, restoration, compression; image processing project.  
Prerequisites: Grade of C or better in ECEN 314; junior or senior classification.

ECEN 447 Digital Image Processing
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Improvement of pictorial information using spatial and frequency domain techniques; two-dimensional discrete Fourier transform; image filtering, enhancement, restoration, compression; image processing project.  
Prerequisites: Grade of C or better in ECEN 314; junior or senior classification.

ECEN 448 Real-Time Digital Signal Processing
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Features and architectures of digital signal processing (DSP) chips; fundamental compromises amongst computational accuracy, speed and cost; real-time implementation of filtering, audio, image and video processing algorithms; rapid prototyping via MATLAB/Simulink.  
Prerequisites: ECEN 444; junior or senior classification.

ECEN 449 Microprocessor Systems Design
Credits 3. 2 Lecture Hours. 2 Lab Hours.
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.  
Prerequisites: Grade of C or better in ECEN 248; junior or senior classification.

ECEN 450 Introduction to Thin Film Science and Technology
Credits 3. 3 Lecture Hours. 1 Lab Hour.
The course focuses on the thin film technology in semiconductor industry; topics include the basic growth mechanisms for thin films (growth models, lattice matching epitaxy and domain matching epitaxy), the instrumental aspects of different growth techniques and advanced topics related to various applications.

Prerequisites: Junior or senior classification.

ECEN 451 Antenna Engineering
Credits 3. 3 Lecture Hours.
Introduction to antenna theory and design; includes antenna performance parameters, analysis of radiation from sources using Maxwell's equations, theory and design of wire antennas, arrays and frequency independent antennas; computer methods for antenna design.  
Prerequisite: Grade of C or better in ECEN 314; junior or senior classification.

ECEN 452 Ultra High Frequency Techniques
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to theory and practice of ultra high frequency radio wave generation, transmission and radiation; application of Maxwell's equations to transmission of electrical energy in wave guides.  
Prerequisites: ECEN 322; ECEN 351 or registration therein.

ECEN 453 Microwave Solid-State Circuits and Systems
Credits 3. 3 Lecture Hours.
Microwave solid-state devices and circuits; theory and design of various types of active circuits; applications of these devices and circuits in radar, communication and surveillance systems.  
Prerequisites: Grade of C or better in ECEN 322; junior or senior classification.

ECEN 454 Digital Image Processing
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Analysis and design of digital devices and integrated circuits using MOS and bipolar technologies and computer aided simulation.  
Prerequisites: Grade of C or better in ECEN 214 and ECEN 248; junior or senior classification.
ECEN 455 Digital Communications
Credits 4.3 Lecture Hours. 3 Lab Hours.
Digital transmission of information through stochastic channels; analog-to-dialog 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.
Prerequisites: Grade of C or better in ECEN 314; junior or senior classification.

ECEN 457 Operational Amplifiers
Credits 4.3 Lecture Hours. 3 Lab Hours.
Analysis of basic operational amplifier and operational transconductance amplifier (OTA) circuits; noise analysis in Op amp and OTA circuits; nonlinear OTA and Op amp circuits; instrumentation amplifiers; transducer circuits; function generators; oscillators and D/A converters and basics of switched-capacitor circuits.
Prerequisite: Grade of C or better in ECEN 325; junior or senior classification.

ECEN 458 Active Filter Analysis and Design
Credits 4.3 Lecture Hours. 3 Lab Hours.
Systematic analysis and design for active RC filters; continuous-time; switched-capacitor circuits; filter approximations; synthesis techniques; sensitivity; practical considerations for monolithic integrated filters; experimental and computer-simulation verification.
Prerequisite: Grade of C or better in ECEN 325; junior or senior classification.

ECEN 459 Power System Fault Analysis and Protection
Credits 4.3 Lecture Hours. 2 Lab Hours.
General considerations in transmission and distribution of electrical energy as related to power systems; calculation of electric transmission line constants; general theory of symmetrical components and application to analysis of power systems during fault conditions.
Prerequisite: Grade of C or better in ECEN 215 or ECEN 314; junior or senior classification.

ECEN 460 Power System Operation and Control
Credits 4.3 Lecture Hours. 2 Lab Hours.
Load flow studies; power system transient stability studies; economic system loading and automatic load flow control.
Prerequisite: Grade of C or better in ECEN 215 or ECEN 314; junior or senior classification.

ECEN 462 Optical Communication Systems
Credits 3.3 Lecture Hours.
Principles of optical communication systems; characteristics of optical fibers, lasers and photodetectors for use in communication systems; design of fiber-optic digital systems and other optical communication systems.
Prerequisites: Grade of C or better in ECEN 322 and ECEN 370; junior or senior classification.

ECEN 463/ BMEN 427 Magnetic Resonance Engineering
Credits 3.2 Lecture Hours. 3 Lab Hours.
Design, construction and application of instrumentation for MR imaging; fundamentals of the architecture of an MR spectrometer and the gradient subsystem used for image localization; emphasis on the radiofrequency sensors and systems used for signal generation and reception.
Prerequisites: BMEN 420 or ECEN 410 or ECEN 411 or approval of instructor; junior or senior classification.
Cross Listing: BMEN 427.

ECEN 464 Optical Engineering
Credits 3.3 Lecture Hours.
Ray optics; wave optics; propagation, reflection, refraction and diffraction of light; passive optical components, polarization, optical modulators, interferometers and lasers.
Prerequisites: Grade of C or better in ECEN 322 and ECEN 370; junior or senior classification.

ECEN 465 Experimental Optics
Credits 4.2 Lecture Hours. 7 Lab Hours.
In-depth study of experimental optic techniques; opto-mechanical assemblies; passive optics; interferometers; opto-electronics; basic op-amp circuits; feedback and control of optics with electronics.
Prerequisite: Junior or senior classification or approval of instructor.

ECEN 468 Advanced Digital System Design
Credits 4.3 Lecture Hours. 3 Lab Hours.
Design, modeling and verification of complex digital systems using hardware description language and electronic system level language.
Prerequisite: Grade of C or better in ECEN 248; junior or senior classification.

ECEN 472 Microelectronic Circuit Fabrication
Credits 4.3 Lecture Hours. 3 Lab Hours.
Fundamentals of MOS and bipolar microelectronic circuit fabrication; theory and practice of diffusion, oxidation, ion implantation, photolithography, etch; yield and reliability considerations; statistical process control; integrated process design, simulation and characterization.
Prerequisites: Grade of C or better in ECEN 325 and ECEN 370; junior or senior classification.

ECEN 473 Microelectronic Device Design
Credits 3.3 Lecture Hours.
General processes for the fabrication of microelectronic devices and integrated circuits; a review of the electronic properties of semiconductors and carrier transport and recombination; analysis and characterization of p-n junctions, bipolar transistors, and MOS capacitors and transistors; design considerations for achieving optimum performance and practical structures are discussed.
Prerequisites: Grade of C or better in ECEN 325 and ECEN 370; junior or senior classification.

ECEN 474 VLSI Circuit Design
Credits 4.3 Lecture Hours. 3 Lab Hours.
Analysis and design of monolithic analog and digital integrated circuits using NMOS, CMOS and bipolar technologies; device modeling; CAD tools and computer-aided design; design methodologies for LSI and VLSI scale circuits; yield and economics; test and evaluation of integrated circuits.
Prerequisite: ECEN 326.

ECEN 475 Introduction to VLSI Systems Design
Credits 4.3 Lecture Hours. 3 Lab Hours.
Introduction to design and fabrication of microelectronic circuits; emphasis on very large scale integration (VLSI) digital systems; use of state-of-the art design methodologies and tools; design of small to medium scale integrated circuits for fabrication.
Prerequisites: Grade of C or better in ECEN 248 and ECEN 325; junior or senior classification.
ECEN 477 Photonics: Fiber and Integrated Optics
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Photonics lab including optical power and spectral measurements of singlemode and multimode optical fibers, hands-on arc fusion splicing, lasers, amplifiers, interferometers, photodetectors, integrated optics, fiber-optic devices, optical modulators.
Prerequisite: Grade of C or better in ECEN 322 and ECEN 370; junior or senior classification.

ECEN 478 Wireless Communications
Credits 3. 3 Lecture Hours.
Overview of wireless applications, models for wireless communication channels, modulation formats for wireless communications, multiple access techniques, wireless standards.
Prerequisites: ECEN 455; junior or senior classification.

ECEN 480 RF and Microwave Wireless Systems
Credits 3. 3 Lecture Hours.
Introduction to various RF and microwave system parameters, architectures and applications; theory, implementation, and design of RF and microwave systems for communications, radar, sensor, surveillance, navigation, medical and optical applications.
Prerequisite: Grade of C or better in ECEN 322; junior or senior classification.

ECEN 485 Directed Studies
Credits 1 to 6. 1 to 6 Other Hours.
Problems of limited scope approved on an individual basis intended to promote independent study.
Prerequisites: Senior classification; approval of department head.

ECEN 489 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 7 Lab Hours.
Selected topics in an identified area of electrical engineering. May be repeated for credit.
Prerequisite: Approval of instructor.

ECEN 491 Research
Credits 1 to 4. 1 to 4 Other Hours.
Research conducted under the direction of faculty member in electrical engineering. May be repeated 3 times for credit. Registration in multiple sections of this course is possible within a given semester provided that the per semester credit hour limit is not exceeded.
Prerequisites: Junior or senior classification and approval of instructor.