DEPARTMENT OF ELECTRICAL ENGINEERING (ELE)

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The Department of Electrical Engineering offers a B.S. in electrical engineering which will equip students with basic competence and job skills needed to design, develop, and operate systems that generate and use electronic signals. These technologies include machinery, electronics, communications, and computers.

Mission

The mission of the Department of Electrical Engineering is to join the university in its commitment to the transmission, expansion, and application of knowledge through teaching, research, and public service. In this commitment, the department features close interaction with area industries and fosters an ongoing exchange of ideas to benefit its students, alumni, and the community at large.

Electrical Engineering Program Educational Objectives

As individuals or as members of teams, our graduates will have:

- A solid background in mathematics, science, and engineering fundamentals that makes it possible to acquire and use contemporary knowledge and tools to practice electrical engineering, in a professional and ethical way, as well as to succeed in graduate education.
- The ability to develop problem-solving skills to design and build systems and to communicate, orally and in writing, with others from inside and outside the profession.

Electrical Engineering Program Outcomes

Our graduates have:

1. Ability to apply knowledge of mathematics, science, and engineering.
2. Ability to design and conduct experiments, as well as to analyze and interpret data.
3. Ability to design a system, component, or process to meet desired needs.
4. Ability to function on multi-disciplinary teams.
5. Ability to identify, formulate, and solve engineering problems.
6. Understanding of professional and ethical responsibility.
7. Ability to communicate effectively.
8. Broad education necessary to understand the impact of engineering solutions in a global and societal context.
9. Recognition of the need for, and an ability to engage in lifelong learning.
10. Knowledge of contemporary issues.
11. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Department Requirements

Candidates for the Bachelor of Science degree in electrical engineering must select their general education courses in the humanities and the arts, social sciences, and interdisciplinary studies in order to satisfy both university requirements and those of the accrediting agency (Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology). These requirements are described under "Special General Education Requirements for Electrical, Industrial and Systems, and Mechanical Engineering Majors" in the College of Engineering and Engineering Technology section of the undergraduate catalog. Students must consult with their faculty advisers to determine appropriate courses.

All electrical engineering students must have their schedules reviewed, approved, and signed by their faculty adviser each semester. ***Any deviation from an approved course schedule may delay graduation.***

During the senior year, electrical engineering majors complete a two-semester senior design project, which is the capstone of the electrical engineering curriculum.

Requirements for a Bachelor of Science with an Emphasis in Electrical & Computer Engineering

(2011-2012 Undergraduate Catalog)

Requirements In Department (41)		**Requirements Outside Department (45)**	
ELE 210	Engineering Circuit Analysis (3)	**CHEM 210***	General Chemistry I (3)
ELE 210U	Engineering Circuit Laboratory Project (1)	**CHEM 212***	General Chemistry Laboratory I (1)
ELE 250	Computer Engineering I (4)	**CSCI 240**	Computer Programming in C++ (4)
ELE 315	Signals and Systems (3)	**ISYE 220**	Engineering Economy (3)
ELE 330	Electronic Circuits (4)	**MATH 229***	Calculus I (4)
ELE 335	Theory of Semiconductor Devices I (3)	**MATH 230**	Calculus II (4)
ELE 340	Electrical Power Systems (4)	**MATH 232**	Calculus III (4)
ELE 356	Computer Engineering II (4)	**MATH 336**	Ordinary Differential Equations (3)
ELE 360	Communications Systems (4)	**MEE 209**	Engineering Mechanics: Statics and Dynamics (4)
ELE 370	Engineering Electromagnetics (3)	**PHYS 253***	Fundamentals of Physics I: Mechanics (4)
ELE 380	Control Systems I (4)	**PHYS 273***	Fundamentals of Physics II: Electromagnetism (4)
ELE 491	Electrical Engineering Design Proposal (1)	**PHYS 283**	Fundamentals of Physics III: Quantum Physics (3)
ELE 492	Electrical Engineering Design Project (3)	**STAT 350**	Introduction to Probability and Statistics (3)
***or* ELE 429**	Biomedical Engineering Design Project (3)	***or ISYE 335***	*Statistics for Engineering (3)*
		UEET 101	Introduction to Engineering (1)

***Available for general education credit.**

Electives (18)

Electives may be any ELE course numbered 400 or higher with the exception of ELE 429, ELE 491, ELE 492, and ELE 497. With the approval of the Department of Electrical Engineering, other mathematics, sciences, or engineering courses may be used as electives. At least 12 of these 18 semester hours must be from the Department of Electrical Engineering, and a minimum of two courses must be selected from one of the following five areas.

Microelectronics: ELE 420, ELE 421, ELE 430, ELE 431, ELE 432, ELE 433, ELE 434, ELE 435, ELE 436, ELE 437, ELE 438

Power/Controls: ELE 440, ELE 441, ELE 480, ELE 481

Signal Processing/Communications: ELE 425, ELE 451, ELE 452, ELE 454, ELE 461, ELE 464

Electromagnetics: ELE 470, ELE 471, ELE 474, ELE 475, ELE 477

Computer Engineering: ELE 452, ELE 455, ELE 457, *or* a computer science course approved by the student's adviser

Total Hours for a Major in Electrical Engineering: 104

Suggested Four-Year Degree Plan: Electrical & Computer Engineering Emphasis

(2011-2012 Undergraduate Catalog)

FRESHMAN YEAR					
***FIRST SEMESTER:* Total 15 Hours**			***SECOND SEMESTER:* Total 18 Hours**		
ENGL 103	Rhetoric and Composition I	3	ENGL 104	Rhetoric and Composition II	3
MATH 229[1]	Calculus I	4	MATH 230	Calculus II	4
PHYS 253	Fund of Physics I: Mechanics	4	PHYS 273	Fund of Physics II: Electromagnetism	4
UEET 101	Introduction to Engineering	1	CSCI 240	Computer Programming in C++	4
GEN-ED[2]	Humanities from LA&S	3	GEN-ED[2]	Humanities from V&PA	3
SOPHOMORE YEAR					
***FIRST SEMESTER:* Total 18 Hours**			***SECOND SEMESTER:* Total 17 Hours**		
MATH 232	Calculus III	4	ELE 250	Computer Engineering I	4
CHEM 210 + 212	General Chemistry I + Lab	4	MATH 336	Ordinary Differential Equations	3
ELE 210 + 210U	Engineering Circuit Analysis + Lab	4	ELE 340	Electrical Power Systems	4
STAT 350	Intro to Probability and Statistics	3	PHYS 283	Fund of Physics III: Quantum Physics	3
or ISYE 335	***or*** Statistics for Engineering (3)		GEN-ED[2]	Humanities from LA&S or V&PA	3
COMS 100	Fund of Oral Communication	3			
JUNIOR YEAR					
***FIRST SEMESTER:* Total 18 Hours**			***SECOND SEMESTER:* Total 14 Hours**		
ELE 315	Signals and Systems	3	ELE 360	Communications Systems	4
ELE 330	Electronic Circuits	4	ISYE 220	Engineering Economy	3
ELE 335	Theory of Semiconductor Dev I	3	ELE 370	Engineering Electromagnetics	3
ELE 356	Computer Engineering II	4	ELE 380	Control Systems I	4
MEE 209	Engineering Mechanics: Statics and Dynamics	4			
SENIOR YEAR					
***FIRST SEMESTER:* Total 16 Hours**			***SECOND SEMESTER:* Total 15 Hours**		
ELE 491	Electrical Engineering Design Proposal	1	ELE 492	Electrical Engineering Design Project	3
TECH ELE[3]	Technical Elective	3	or ELE 429	Biomedical Engineering Design Project	
TECH ELE[3]	Technical Elective	3	TECH ELE[3]	Technical Elective	3
TECH ELE[3]	Technical Elective	3	TECH ELE[3]	Technical Elective	3
GEN-ED[2]	Social Science	3	TECH ELE[3]	Technical Elective	3
GEN-ED[2]	Interdisciplinary	3	GEN-ED[2]	Social Science	3

Total Hours for Degree Program: 131

[1]Placement examination needed.
[2]Your adviser must approve your general education courses.
[3]Electives may be any ELE course numbered 400 or higher with the exception of ELE 429, ELE 491, ELE 492, and ELE 497. With the approval of the Department of Electrical Engineering, other mathematics, sciences, or engineering courses may be used as electives. At least 12 of these 18 semester hours must be from the Department of Electrical Engineering. Also see, "Department Requirements."

ELECTRICAL ENGINEERING COURSE LIST

ELE 100. Elements of Electronics (3). Basic principles used to explain the operation of electrical and electronic devices such as radios, stereos, televisions, radars, computers, microwave ovens, and other common electronic equipment. **Does NOT count as credit for EE majors.**

ELE 210. Engineering Circuit Analysis (3). Properties of electric circuit elements, Ohm's and Kirchhoff's laws; node and loop equations; AC sources and impedance; time domain transient and frequency domain; and steady state analysis. Three lectures and one recitation per week. PRQ: MATH 230 and PHYS 273 with a grade of C or better.

ELE 210U. Engineering Circuit Laboratory Project (1). Laboratory to design and build electrical circuit projects. Team project must be designed and implemented by the end of the semester. Meets two hours a week. CRQ: ELE 210.

ELE 250. Computer Engineering I (4). Design of digital circuits using SSI, LSI, and VLSI components. Combinational design techniques as well as sequential design techniques presented with the use of Boolean algebra, map method, tabulation method, and state transition diagrams. Lecture, discussion three periods per week; laboratory, problem session two periods per week. PRQ: ELE 210 and ELE 210U, both with a grade of C or better.

ELE 315. Signals and Systems (3). Analysis of RLC circuits with applications to filters; Bode Plot; Fourier transforms, Laplace transforms, introduction to discrete time systems; 2-port network. PRQ: ELE 210 with a grade of C or better and MATH 336.

ELE 330. Electronic Circuits (4). Unified treatment of the applications of semiconductor devices, including p-n junctions, bipolar transistors, and field effect devices. Topics include device modeling, biasing, input impedance, output impedance, voltage gain, current gain, and power gain and Op. Amp. design and analysis of single and multiple stage amplifiers. Lecture, discussion three periods per week; laboratory session two periods per week. PRQ: ELE 210U and MATH 336.

ELE 335. Theory of Semiconductor Devices I (3). Unified treatment of the theory of operation of semiconductor devices, including p-n junctions, bipolar transistors, and field effect transistors. Topics include doping, band gap, mobility, carrier lifetime, photolithographic techniques, passivation, chemical etching, metallization, and device testing. PRQ: CHEM 210T and CHEM 212 with a grade of C or better, ELE 210, and PHYS 283.

ELE 340. Electrical Power Systems (4). Study of the fundamentals of magnetic circuits and Faraday's law to create electrical or mechanical energy. Study of transformers, mutual inductance, 3-phase power systems, induction motors, synchronous machines, and DC machines, with emphasis on the applications in engineering practice. Lecture, discussion three periods per week; laboratory, problem session two periods per week. PRQ: ELE 210 with a grade of C or better and PHYS 273.

ELE 356. Computer Engineering II (4). Analysis of microprocessors with emphasis on architecture, bus cycle, internal registers, addressing modes, and instruction sets. Memory and I/O interface techniques. Lecture, discussion three periods per week; laboratory, problem session two periods per week. PRQ: CSCI 240 or other high-level programming language, and ELE 250.

ELE 360. Communications Systems (4). Introduction to communication system analysis. Analysis and design of radio frequency electronic circuits; building blocks of radio transmitters and receivers; circuit conditions required to produce oscillation, frequency translation, modulation, and detection. Introduction to phase locked-loop circuit design. Lecture, discussion three periods per week; laboratory, problem session two periods per week. PRQ: ELE 315, ELE 330, and ISYE 335 or STAT 350.

ELE 370. Engineering Electromagnetics (3). Fundamentals of electromagnetic field theory; concepts of force, energy, potential, capacitance, and inductance in electromagnetic fields; analytical and experimental solutions of Laplace's equation; Maxwell's equations in differential and integral form. PRQ: ELE 210, MATH 232, and MATH 336.

ELE 380. Control Systems I (4). Control system modeling for electromechanical systems using block diagram, flow chart, flow graphs, and derivation of transfer function using Laplace transforms. Time and frequency domain analysis and controller design using root-locus, Routh-Hurwitz stability method, and Bode Plots. Software for control system used as an aid in the control system analysis and design process. PRQ: ELE 315 and ELE 330.

ELE 420. Biomedical Instrumentation (4). Design and application of electrodes, bio-potential amplifiers, biosensor applications, therapeutic devices. Medical imaging. Electrical safety. Measurement of ventilation, blood pressure and flow. Three hours lecture per week and 10 laboratory sessions (3 hours each). PRQ: ELE 330, or consent of department.

ELE 421. Biomedical Sensor Engineering (3). Theory, analysis, and design of biomedical sensors. Topics include biological elements; immobilization of biological components; medical, biological, and chemical sensors; and transducers based on electrochemistry, optics, and solid state devices. PRQ: ELE 330 and ELE 335, or MEE 390, or consent of department.

ELE 425. Biomedical Signal Processing (3). Modeling of biomedical signals and analysis of biomedical systems using both time-domain and frequency-domain techniques. Design of linear and nonlinear filters for biomedical applications and medical imaging. Practical applications in cardiac and neurological signal processing. Not available for credit to students with credit in ELE 451. PRQ: ELE 315 or consent of department.

ELE 429. Biomedical Engineering Design Project (3). Students create a solution to the proposed biomedical engineering design problem. The solution incorporates knowledge of biological sciences, engineering and design concepts. Analytical and computational tools address the complete solution which includes safety and cost effectiveness. Team project required. PRQ: ELE 420 and ELE 425 and ELE 491 and completion of all ELE 300-level courses required by the major.

ELE 430. Design with Field Programmable Logic Devices (3). Design of high performance logic designs utilizing programmable logic gates. Design of finite state machines and introduction to latest computer-aided tools. PRQ: ELE 250 or consent of department.

ELE 431. Theory of Semiconductor Devices II (3). Continuation of ELE 335 dealing with complex semiconductor devices. Theory of operation of integrated circuits, solid state lasers, switching devices, and negative conductance microwave devices. PRQ: ELE 335.

ELE 432. Semiconductor Device Fabrication Laboratory (3). Design and fabrication of active semiconductor devices. Laboratory exercises include artwork and pattern generation, mask making, oxidation, photolithographic processing, diffusion, metallization, and device testing. PRQ: ELE 335 or consent of department.

ELE 433. Design of Gallium Arsenide Integrated Circuits (3). Fundamentals of GaAs devices and logic families; fabrication processes; physical layout for VLSI circuits; interconnection and testing of high speed systems. PRQ: ELE 335.

ELE 434. Semiconductor Material and Device Characterization (3). Study of fundamentals and principles of semiconductor material properties with applications to device characterization. Modern measurement techniques of semiconductor industry including electrical, optical, chemical, and physical methods. PRQ: ELE 335 or consent of department.

ELE 435. Integrated Circuit Engineering (3). Basic theory of integrated circuits including MOS processing technology. Principles of layout design, simulation, and design rule checking of large-scale integrated circuits. Introduction to design tools and techniques including utilization of available design software packages. Requirements include the design, simulation and layout of an integrated circuit to the point of mask generation. PRQ: ELE 250 and ELE 330.

ELE 436. Analog MOS VLSI Engineering (3). Introduction to analog MOS (nMOS and CMOS) circuits. MOS transistor as both a switch and a linear device. Different MOS circuits such as amplifiers, switches, comparators, sensors, D/A-A/D converters, multipliers, and neural networks are investigated. PRQ: ELE 330 or consent of department.

ELE 437. Hybrid Circuit Design (3). Lecture/laboratory course covering thick film processing techniques as they apply to the design and fabrication of miniature electronic circuits. Topics include minimum design rules, design of electronic components, artwork generation, screen preparation, screen printing, drying and firing profiles, and trimming. PRQ: Senior standing.

ELE 438. Thin Film Engineering (3). Lecture/laboratory course designed to demonstrate theory and principles of thin film processing including vacuum processing and deposition techniques. Topics include resistive evaporation, DC sputtering, RF sputtering, ion beam sputtering, electron beam evaporation, methods of achieving vacuum, and measurement techniques. PRQ: ELE 335.

ELE 440. Power Electronics (3). Introduction to concepts involved with switch mode power electronic circuits. Analysis of basic circuit topologies including AC/DC, DC/DC, and DC/AC converters. Discussion of the desired outputs of these circuits as well as undesired components such as harmonies and ripple. PRQ: ELE 330 and ELE 340.

ELE 441. Electric Drives (3). Advanced discussion of different types of electric motors under various load conditions. Application of power electronic drives to electric motors. Topics include DC drives, AC induction motor drive, and AC synchronous motor drives. Efficiency and harmonic effects discussed for each drive system. PRQ: ELE 330 and ELE 340.

ELE 450. Digital Design with HDL (3). Design, simulation, and synthesis of digital circuits and systems using Verilog HDL or VHDL. Topics include digital design methodologies, finite state automata, behavioral models, structural design, finite state machines and datapath controllers, and algorithms and architectures for digital signal processors. Includes term project to design, simulate, and synthesize a digital circuit/system. PRQ: ELE 250 and CSCI 240, or consent of department.

ELE 451. Digital Filter Design (3). Difference equations, z-transform, Fourier representation of sequences, discrete-time system transfer functions, and infinite impulse response discrete-time filters design. Includes implementation considerations and computer aided filter design. Practical examples and computer simulations. PRQ: ELE 315.

ELE 452. Real-Time Digital Signal Processing (3). In-depth presentation of the use of single-chip programmable signal processors. Hardware design aspects of digital signal processing (DSP) systems, architectural issues, and fixed versus floating pointing representations for implementing DSP algorithms. Applications to speech processing, adaptive filtering, and telecommunications. PRQ: ELE 315 and ELE 356, or consent of department.

ELE 454. Introduction to Digital Image Processing (3). Principles, techniques, and algorithms for enhancements of degraded images, compression of pictorial information, recognition of patterns in scenes, reconstruction of a picture from projections, and descriptions of objects in a scene. PRQ: Senior standing, CSCI 240, and consent of department.

ELE 455. Computer System Architecture (3). Register transfer and micro-operation, basic computer organization and design; central processing unit; micro-programmed control; pipeline and vector processing; computer arithmetic; input/output organization, and memory organization. PRQ: ELE 250.

ELE 456. Introduction to Pattern Recognition (3). Theory and design of pattern recognition systems. Topics include pattern recognition and perception, nonparametric decision theoretical classification, statistical discriminant functions, Fisher's approach, unsupervised learning systems (clustering) and their performance, and neural networks for pattern recognition. PRQ: CSCI 240 or CSCI 241, ELE 250, and STAT 350 or ISYE 335, or consent of department.

ELE 457. Microprocessor (3). Analysis of computer logic systems. Topics include parallel and serial I/O ports; memory interface, I/O interface, and interrupt interface. PRQ: ELE 356.

ELE 461. Synthesis of Active and Passive Filters (3). Principles of network synthesis are introduced. Synthesis techniques are used to design active and passive filters. PRQ: ELE 315 and ELE 330.

ELE 464. System Design Utilizing Analog Integrated Circuits (3). Basic theory for the utilization of special purpose integrated circuit amplifiers in application specific to circuit designs, including special differential and operational amplifier circuits. PRQ: ELE 330.

ELE 470. Microwave Circuits and Devices (3). Wave equation; microwave waveguides and components; solid-state devices and circuits; microwave integrated circuits; microwave test equipment and laboratory measurements. PRQ: ELE 370.

ELE 471. Lightwave Engineering (3). Theory, analysis, and design of opto-electronic communication techniques. Multimode and mono-mode optical fibers examined for loss, dispersion, and practical considerations. Optical receiver, transmitter, and repeaters presented with an introduction to optical signal processing. PRQ: ELE 335, ELE 360, and ELE 370, or consent of department.

ELE 474. Transmission Line Media and Wave Propagation (3). Theory and applications of various transmission line media such as two-wire, coaxial, stripline, and microstrip lines. Principles of wave propagation in freespace and waveguides. Distributed circuits and impedance matching using the Smith chart approach. PRQ: ELE 370.

ELE 475. Antenna Theory and Design (3). Fundamentals of electromagnetic radiation from wire and aperture-type antennas; applications of field equivalence principles to aperture radiation; receiving antennas and noise evaluation of communication systems; antenna test equipment and measurement techniques. PRQ: ELE 370.

ELE 477. Advanced Microwave and Millimeter Wave Engineering (3). Analysis of various transmission-line media, including rectangular and circular waveguides, dielectric waveguides, finlines, and microstrip transmission lines; microwave/millimeter wave passive and active components; theory and design of integrated circuits, such as receiver front-ends; application of microwave systems and measurement techniques. PRQ: ELE 370.

ELE 480. Control Systems II (3). Design and compensation of feedback control systems. State-variable approach to the analysis and design of feedback control systems. Use of digital controllers in modern control systems. PRQ: ELE 380 or MEE 322.

ELE 481. Digital Control Systems (3). Introduction to digital and sampled-data control systems. Analysis and design of digital systems using z-transform and state-space methods. Study of the effects of quantization and sampling upon stability and performance. PRQ: ELE 380.

ELE 491. Electrical Engineering Design Proposal (1). Discussion of global impacts of engineering designs including social, environmental, and ethical concerns as well as modern topics in electrical engineering. Development of a proposal for a senior design project that addresses these concepts. Educational programs and career opportunities for electrical engineers are addressed. For electrical engineering students only. Team project required. PRQ: Consent of department.

ELE 492. Electrical Engineering Design Project (3). Students create a solution to the proposed engineering design problem. The solution is to incorporate engineering design concepts, including safety and cost effectiveness, as well as employ analytical and computer tools. Team project required. PRQ: ELE 491 and completion of all ELE 300-level courses required by the major.

ELE 497. Independent Study (1-3). Independent pursuit of problems in electrical engineering under faculty supervision. Written report required. May be repeated to a maximum of 3 semester hours. PRQ: Consent of department.

ELE 498. Special Topics (1-3). Regularly scheduled courses in advanced topics in electrical engineering. May be repeated to a maximum of 3 semester hours. PRQ: Consent of department.

A. Biomedical Engineering	E. Communications Engineering
B. Microelectronics	G. Electromagnetics
C. Power Electronics	J. Control Systems
D. Computer Engineering	K. Digital Signal Processing

ELE 499H. Honors Undergraduate Research (1-3). Pursuit of an undergraduate research topic in electrical engineering under faculty supervision. Written report required. May be repeated to a maximum of 3 semester hours over two or three semesters. PRQ: Consent of department.

NOTE: A grade of "C" or better is required in the following courses.

CHEM 210 - General Chemistry I	MATH 229 - Calculus I
CHEM 212 - General Chemistry Lab I	MATH 230 - Calculus II
ELE 210 - Engineering Circuit Analysis	MEE 209 - Engineering Mechanics: Statics and Dynamics
ELE 210U - Eng. Circuit Analysis Lab Project	PHYS 253 - Fundamentals of Physics I: Mechanics
ENGL 103 - Rhetoric and Composition I	PHYS 273 - Fundamentals of Physics II: Electromagnetism
ENGL 104 - Rhetoric and Composition II	

Please see your advisor and complete an advising form each semester before registering for any courses.

Upd 2011-12